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CONCRETE SHIPS

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Ship digest

A POSSIBLE SOLUTION
of the SHIPPING PROBLEM

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Concrete for Permanence

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SHIPS, more ships, and still more ships, is the need of the hour. To supply them quickly is a military necessity. This booklet has been prepared to suggest a possible means of solving the problem.



400-ton concrete motorship built by Fougner's Steel Concrete Shipbuilding Co., at Moss, Norway, during the summer of 1917. This boat is now in ocean service between Norway and England.

Lloyd's Approval of Concrete Ships

Editorial from *International Marine Engineering*, November, 1917

Lloyds recent approval of plans for the construction of several reinforced concrete ships with a view to classification by the society means that the ferro-concrete, seagoing, self-propelled vessel has become — within certain limits of size — a practical proposition. Now that the basic principles upon which this form of shipbuilding rests have been fully accepted, the problem resolves itself into a question of how far such a design may be developed safely in its application to larger ships. The plans already approved by Lloyds cover a number of non-propelling barges, some of which are designed to carry as much as 500 tons deadweight, and a motor vessel for coastwise trade between Great Britain and Scandinavian countries. These vessels will be built in the United Kingdom and Norway under the inspection of Lloyd's surveyors and plans for other similar vessels, but of larger carrying capacity, are now under consideration.

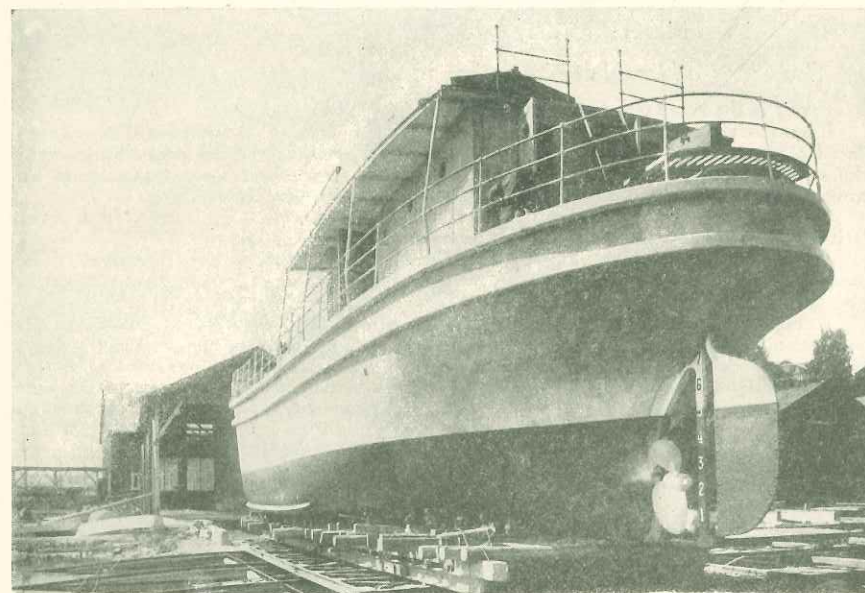
DECEMBER, 1917.

CONCRETE SHIPS

A Possible Solution of the Shipping Problem

SHIPS A VITAL FACTOR IN WINNING THE WAR

WE are in the war to win. Now that we are in it, we face the need of immediately adding to our shipping a large tonnage in the shortest time possible. To move our army to the battlefield of Europe and to keep it and our allies in the best of fighting trim requires ships — and more ships. Nothing will hasten the winning of this war more than increasing the speed of the shipbuilding program. Not only are ships needed for army and other transport, but to replace the losses caused by Germany's unrestricted U-boat warfare. Demands now being made for water transport far exceed anything ever known.



View of the hull of the 400-ton motorship built by Fougner's Steel Concrete Shipbuilding Co., Moss, Norway, as the vessel appeared on the ways prior to launching. Note the pleasing lines of the hull, indicating that concrete is adaptable to the requirements of naval architecture.

HOW MANY SHIPS BE SECURED?

In the past we depended upon foreign shipping and shipbuilders for ocean transport, but the demands of war have so drawn upon the supply of steel and wood that another shipbuilding material must be found to help

Page Three

out in this crisis. There are no large stocks of suitable timber available to meet the present emergency. The supply of steel plate does not meet the demand. These conditions increase the difficulty of speedily building a sufficient number of ships for our war needs.

It is true that great efficiency has been injected into today's shipbuilding program by developing standard designs for steel and wood ships and so co-ordinating the operations of various plants that production has been enormously speeded up. Wherever steel plates could be secured, every assistance has been given plants to secure materials and labor. Wood ships have been started and rushed to completion in every yard that has been able to obtain necessary materials and skilled ship labor. Interned enemy ships have been refitted and placed in service. Vessels of 2,500 tons and over have been withdrawn from the Great Lakes and placed in coastwise or ocean traffic. But all tonnage that can be produced under present methods will not meet today's shipping needs.

DELAY IS THE ENEMY

The *Chicago Herald* of November 12, 1917, said:

Speed is the sole test of the success of the shipbuilding program.

To maintain an American army in Europe it is necessary to unload in France every day 100 pounds of freight per man. This hundred pounds includes everything used in the operation of any army; locomotives and hay, rails and jam, ammunition and towels, big guns and soap, automobiles and tooth brushes — everything.

One hundred pounds per day per man is a conservative estimate. In a recent British offensive 148 pounds per man were necessary to do the job.

Does the average man realize what these figures mean in ship tonnage? They mean a daily flow into France of 50,000 tons of freight for our proposed army of 1,000,000 men.

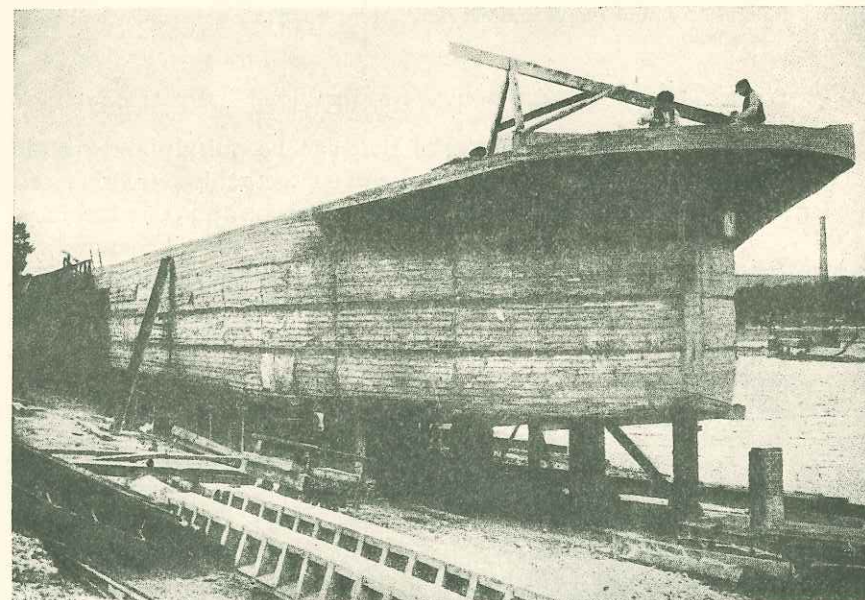
Expert dock labor will unload 2,000 tons a day from a ship if it has up-to-date mechanical contrivances. Therefore, as the average freighter carries 4,000 tons of cargo, it will be necessary to unload 2,000 tons a day from twenty-five ships. In order that this flow of 50,000 tons of supplies a day may be uninterrupted it will be necessary to have east bound on the ocean at least twelve times twenty-five loaded ships — 300 ships — and twelve times twenty-five ships returning westward in ballast — 300 more ships. And there must be the necessary number of vessels in port on both sides.

In other words, there must be a continuous ferry service between America and France of at least 700 ships in daily motion for our own army. This does not take into account any accidents that may happen to the machinery of ships; it disregards submarines, delays in loading and unloading cargoes and other of the mishaps of mariners.

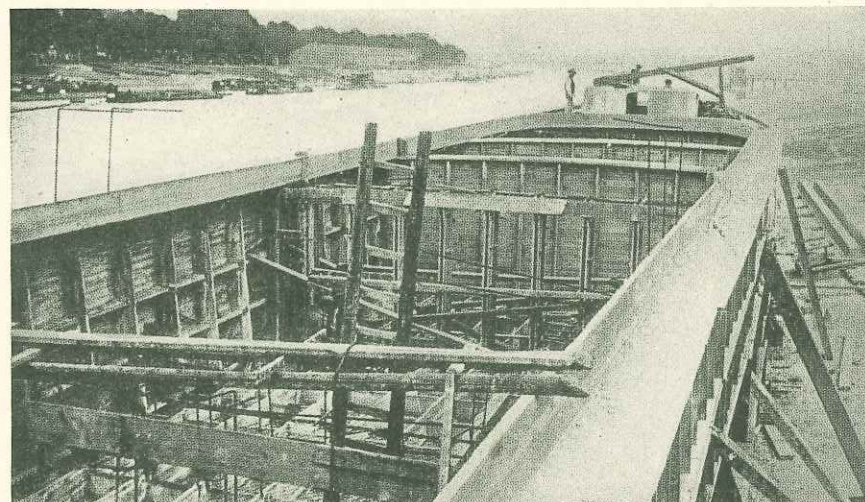
These cold figures show how essential rapid shipbuilding is to the success of American arms. From the standpoint of the necessity of sharing our food with our allies who have so long borne the brunt of the war, the urgency is not less great. And other ships must carry this freight.

Neither "too late" nor "late" must be the comment of history upon America's emergency fleet. Time is the enemy. Delay must be overcome. Immediacy of production is the goal. For this reason the reorganization of the emergency fleet corporation must evoke instantaneous approval, combined with regret that in a crisis such as this such action should be necessary. In its ship construction program the Government needs precisely those talents which the more competent business executives have developed during the last few years. It has needed such talent for nearly a year and, judging from the recent events, hasn't had it. Some day it will be pertinent to ask why.

A supreme task must swiftly be carried to its conclusion. Six million tons of shipping must be completed during 1918. No explanation of why the program failed



Exterior view of one of numerous similar concrete boats or lighters now in use or being built for use on French rivers and other inland waterways. This one was built on the Paris Ship Canal during 1917.



A view of the interior of concrete lighter shown above, many of which are now being built in France. These are used largely in river traffic to transport war munitions and supplies.

CONCRETE SHIPS

will explain. The strengthening of the emergency fleet corporation is designed to forestall failure. Admiral Capps and his associates will still keep their minds at work upon the designs for ships.

CONCRETE SHOULD HELP TO SOLVE THE PROBLEM

Concrete is a shipbuilding material that can be quickly and readily obtained in large quantities — and the idea of concrete ships is neither new nor fantastic. For many months newspapers, marine and technical journals have advanced good reasons why concrete is a logical material for ship construction; and these reasons have been fortified by illustrations of what actually has been and is being done today with concrete in building boats, barges and even ocean-going vessels.

WHY CONCRETE IS A LOGICAL SHIPBUILDING MATERIAL

There are many reasons why concrete is a logical material for ship construction. Several of these are especially applicable to the present situation:

Materials required for constructing concrete vessels are available in necessary quantities, all along our coasts and waterways.

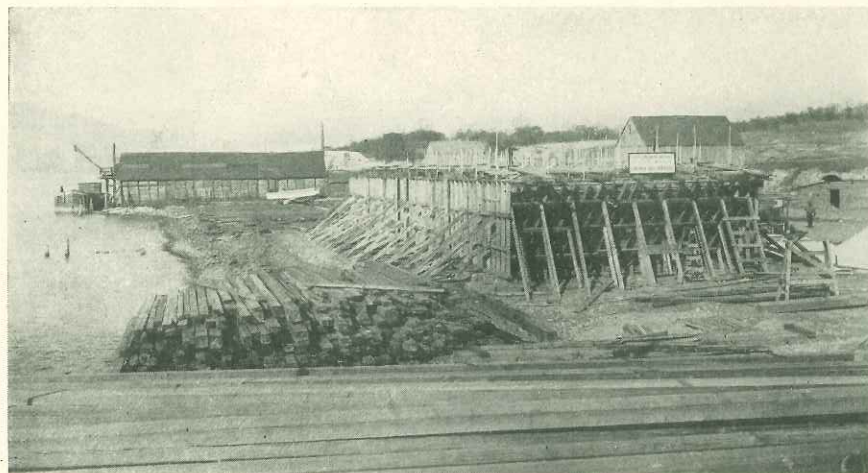
Little skilled labor is required.

Concrete vessels can be constructed rapidly.

Concrete ships are reasonable in cost.

Concrete ships will not burn.

Concrete ships are rotproof and ratproof.



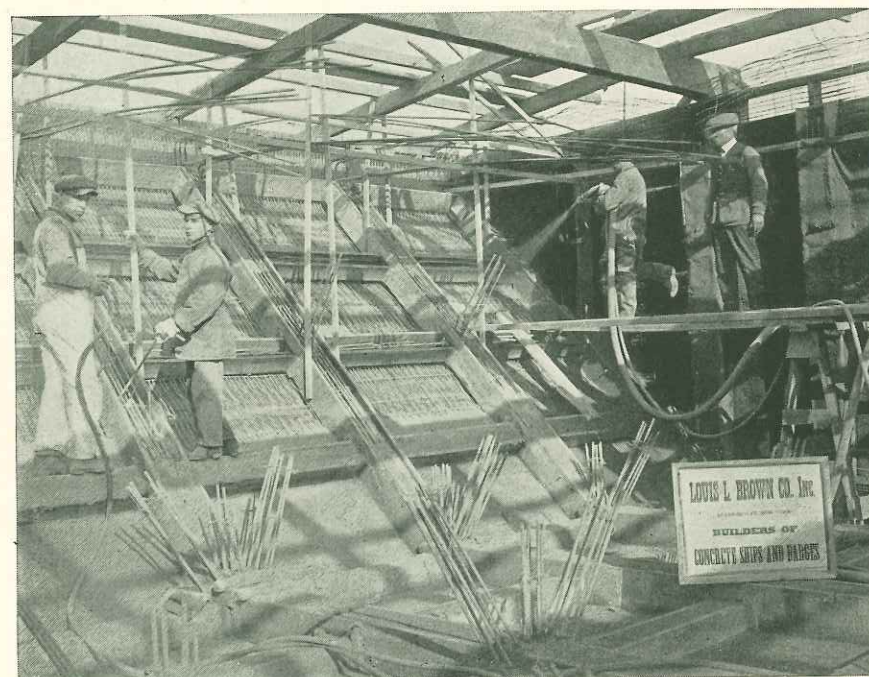
Form work for 700-ton concrete barge being built by Louis L. Brown Co., Inc., near New York. This barge is in position, as will be seen, for a broadside launching.

CONCRETE SHIPS

Concrete vessels can be kept in constant service because there are few maintenance requirements.

Concrete ships built to supply present needs will be equally useful after the war when industry will demand shipping facilities probably even greater than at present.

Concrete has been used in every form of construction. It is a known quantity. Ships can be designed in concrete to meet every requirement.



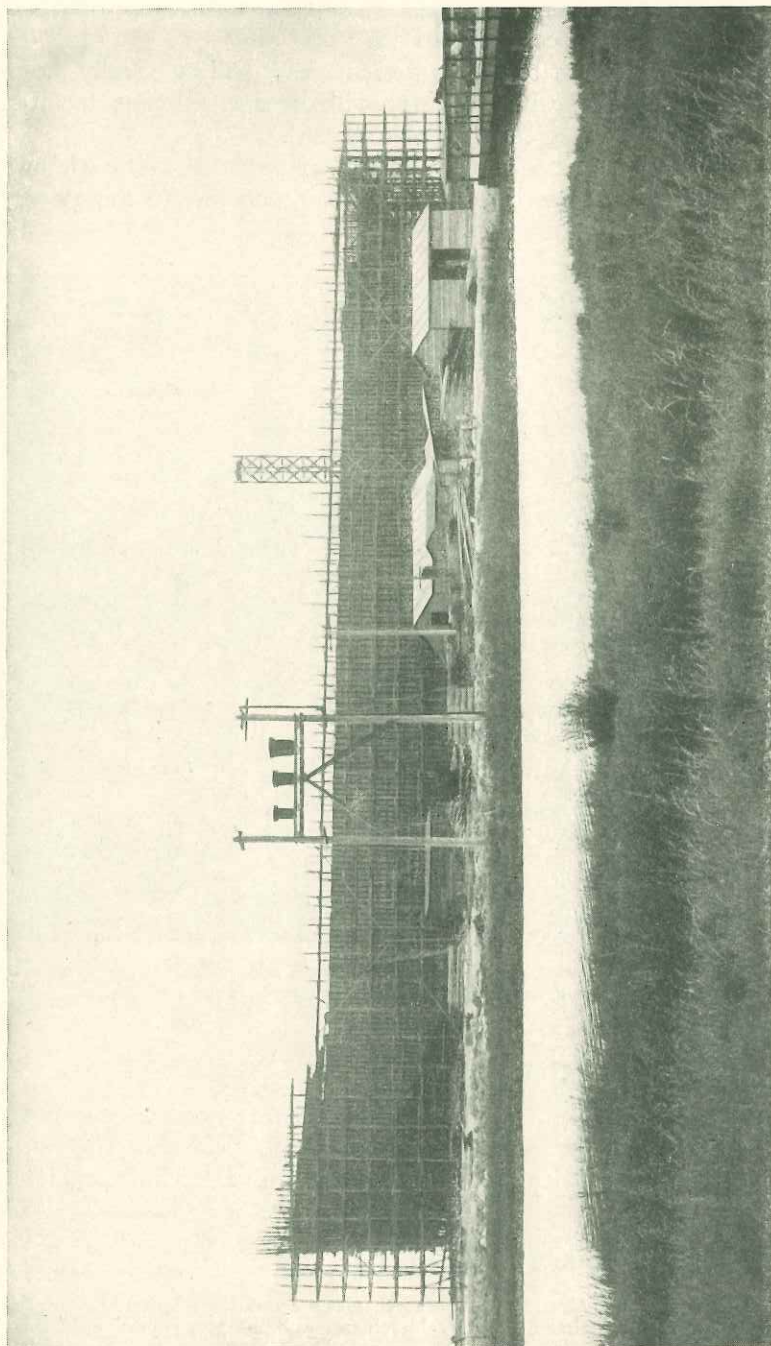
700-ton concrete barge under construction near New York. Work is being done by the Louis L. Brown Co., Inc., builders of concrete ships and barges.

WHAT THE PRESS IS SAYING

Leading papers throughout this country and abroad have not only realized the need of immediately solving the shipping problem, but have recognized the fact that concrete is likely to prove itself adaptable to the present situation.

The *Boston Evening Record* says:

It is by the careful study and research given by the specialists, the marine engineer, the concrete engineer, the naval architect and the gun expert, each doing his



Progress view of the exterior of 4500-ton reinforced concrete ship under construction at Redwood City, Cal. This vessel will probably be launched early in 1918 and is being built for transpacific service.

own part, that the problem will be successfully solved and will bring forth the ship of such sturdy strength that on the new ship the submarine will have lost its power.

Many are conversant with the feats of engineering accomplished with reinforced concrete; factories and manufacturing plants having great strength and practically free from vibration, bridges capable of carrying any load, are demonstrated facts, but its possibilities in modern shipbuilding are not so well known. But nearly every country in the world is making some use of reinforced concrete as applied to shipbuilding. It remains for the methods to be thoroughly worked out and perfected by specialists to give us practically an indestructible ship.

In the July, 1917, issue of *Marine Engineering*, the following editorial appeared:

REINFORCED CONCRETE SHIPBUILDING — A FIELD FOR PIONEERS

The pressing need for ships and the existing congestion in American shipyards have led to a consideration of the possibility of utilizing other materials than wood and steel for shipbuilding. The most promising alternative is undoubtedly reinforced concrete, and already several prominent engineers have turned their attention to its application to the construction of ships. Various phases of the question are discussed in two articles published elsewhere in this issue.

Railway and Marine News (Seattle) in its November 1917 issue, reprints an article that appeared in the *London Daily Telegraph*, referring to a recent parliamentary statement made by Lloyd-George regarding the shipping problem. The following is taken from the article mentioned:

Now why, we would ask, cannot the government department responsible for the construction of merchant ships give orders for the building of concrete ships, thereby freeing for gun, shell and other munitions production, much of the steel that would otherwise be required for shipbuilding?

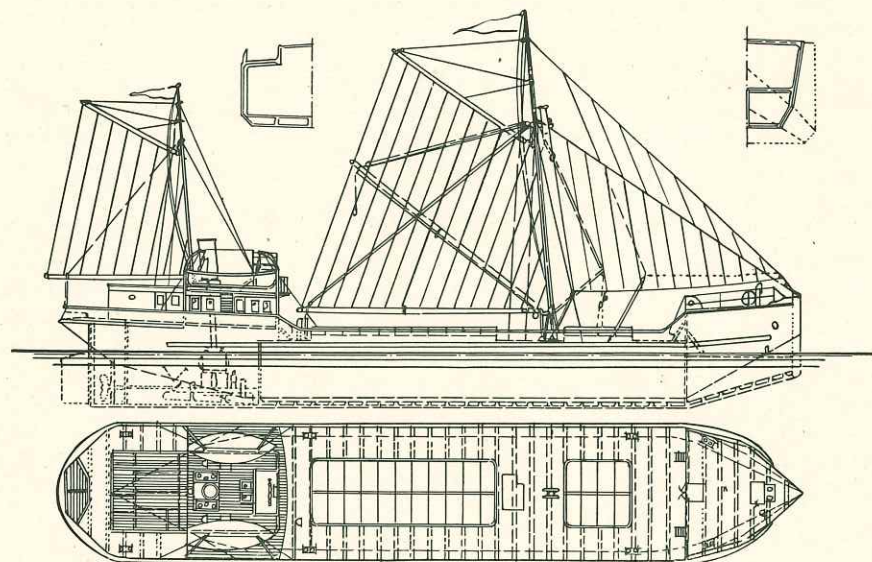
Of the soundness of the system there can be no doubt. Some indication of this and of what other countries are doing in the matter of concrete ship construction was given on this page a fortnight ago. British naval architects have already prepared designs for standard concrete ships, for which they are ready to quote firm prices and to guarantee results. Costs will be found to be distinctly lower for ships made of reinforced concrete than for vessels of similar capacity built of steel. We have the authority of a valued correspondent for the statement that the cost of ships constructed of reinforced concrete may be safely put at one-third of that for steel vessels.

Nor do the advantages of concrete ships end here. There is the additional advantage — one of the most important of all in these days when the need for quickly replacing the tonnage sunk by German submarines is so claimant — that concrete ships can be constructed far more rapidly than can those of steel, requiring for their construction less labor and labor of a lower degree of skill than that needed for ordinary shipbuilding.

The *Merchant Service Review & R. N. R. Gazette*, Liverpool, October, 1917, said:

Apropos of the article on "Cargo Ships of Concrete" in another part of this issue support of the writer's views on present day development in this direction is found in the recently published statement as to the attitude of Lloyd's Register of Shipping towards the movement. According to the statement referred to, the Committee of Lloyds have approved plans for the construction of a number of non-propelling barges, some of them designed to carry 500 tons deadweight, and also of a motor vessel to be built of ferro-concrete in the United Kingdom and one in Norway, for the British and Scandinavian coastal trades. These vessels will be built under the inspection of the Society's surveyors, with a view to classification in Lloyd's Register Book. Plans of

other ferro-concrete vessels of larger carrying capacity for certain sea trades are at the present moment under consideration. The ferro-concrete system of construction has so far been most developed in Scandinavia, and one of the Society's principal surveyors has recently made a tour of inspection in these parts, whose report yields to the Society a good deal of valuable data on the subject. What is here stated regarding Lloyds' interest in and preliminary work on ferro-concrete construction applies to at least an equal extent to the other shipping Registries — the Bureau Veritas, and the British Corporation. Both bodies have already had large numbers of definite propositions before them, and certain members of the staff in each case have been told off to give special study and attention to the various proposals brought forward. Unfortunately it would appear, from various sources of intelligence open to us, that designers and would-be owners and builders of ferro-concrete craft are not receiving the encouragement from Governmental Departments which they naturally look for in these times when almost every day we are being told that "ships and still more ships are required." Manufac-



Design for a reinforced concrete vessel, by James Pollock, Sons & Co., Ltd., London. Dimensions, 125 by 25 by 11.6 feet. Draught 9.9 feet with 300 tons cargo, free-board 1.9 feet. All curved work is dispensed with in the above design and the rods are practically straight throughout.

turers of rods and meshed steel for reinforcement are not being helped to meet the demands for material which have arisen, and are likely to increase. This is certainly not as it should be, and if sooner or later firms and individuals who are at present full of initiative and keenness become disappointed and disheartened, it may not only discourage enterprise and ingenuity in a promising shipping development, but prove a serious matter for us as a maritime nation.

The Engineering Supplement of the *London Times*, May 25, 1917, after citing some examples of the use of concrete in boats and barges, discusses the possibility of future developments as follows:

It is evident from the examples cited that reinforced concrete has earned a definite claim to be regarded as a real shipbuilding material, particularly for vessels of moderate size. Whether it will prove equally suitable for the construction of larger steamships,

including ocean liners and warships, is a question that can be answered only by the results of future experience. In the meantime the material possesses obvious advantages for the building of many useful types of craft. Among its recommendations are simplicity and rapidity of construction, the readiness with which repairs can be executed, high resistance to strain and shock, incombustibility and fire-resistance, relatively low cost, and the virtual elimination of maintenance charges. Experience appears to show that the skin-resistance of a reinforced concrete vessel to passage through water is slight, owing to the smoothness of the surface and the absence of joints, and the ease with which scraping can be effected.

... reinforced concrete lends itself to the most modern developments in shipbuilding design, and although the skin of the hull must necessarily be thicker than when steel plates are used, it need scarcely be thicker than would be the case if timber were employed. Assuming 3 inches to be the thickness adopted, the weight per square foot would be less than that of steel 1 inch thick. Therefore the question of dead-weight does not appear to constitute a very serious objection, especially in view of the fact that the weight of the hull of a vessel is small in comparison with the weight of equipment, fittings, and cargo.

Even if large ocean-going concrete ships are not at once made a reality, there is no end of opportunity to construct barges and lighters for lake, river, and coastwise service. Any considerable number of such carriers would at once release for ocean-going use, other ships now in Great Lakes or coastwise traffic.

This thought has been well expressed by the editor of the *Great Lakes Weekly*, a paper devoted to shipping interests on the Great Lakes, published in Milwaukee, who says:

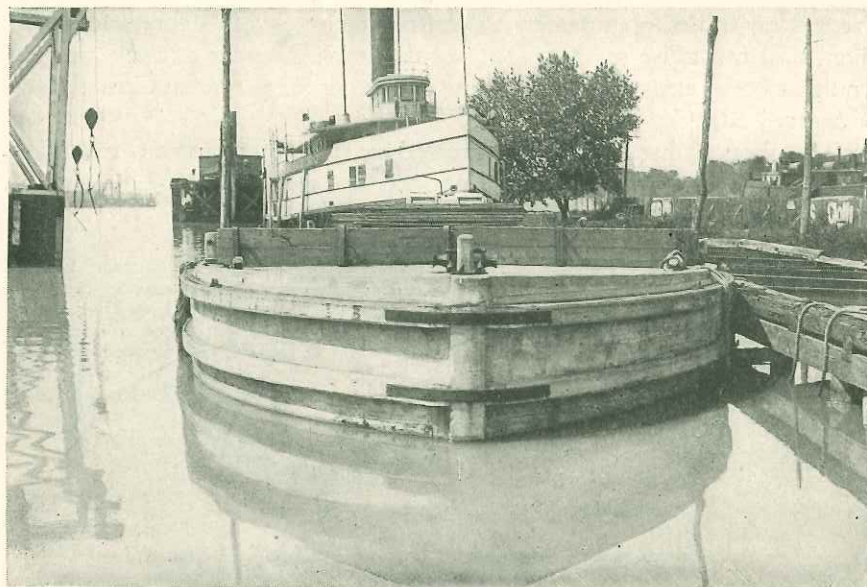
There is no reason why there should not be a great field for these concrete barges and ships on the Great Lakes. Every kind of an old trap and almost every bottom that floats is being used and I believe that if the shipping men, especially those that are in the class for smaller tonnage, could be educated up to this new kind of shipbuilding there would soon be something doing in the marine field. They are having considerable trouble on Lake Erie and Lake Ontario to get sufficient tonnage especially in the coal field between American and Canadian ports, and barges or ships of this kind of construction could be utilized in that field.

Application of Concrete to Shipbuilding

SOME FUNDAMENTAL REQUIREMENTS

Ship hulls must be made of a material that is stiff enough to prevent buckling between ribs. Concrete will accomplish that end. Shaping it to conform to the lines required is merely a matter of depositing it between forms having the desired lines. It can be finished so smooth that skin friction will be reduced to a minimum and sea growths will find no opportunity for attachment.

Concrete in its plastic state lends itself to any shape. There is no joining as required with wood. There are no rivets nor bolts to be loosened



This is a front view of the barge "Pioneer" in use for several years on the Welland Canal.

by jars or strains. Reinforced concrete uses steel most effectively and economically.

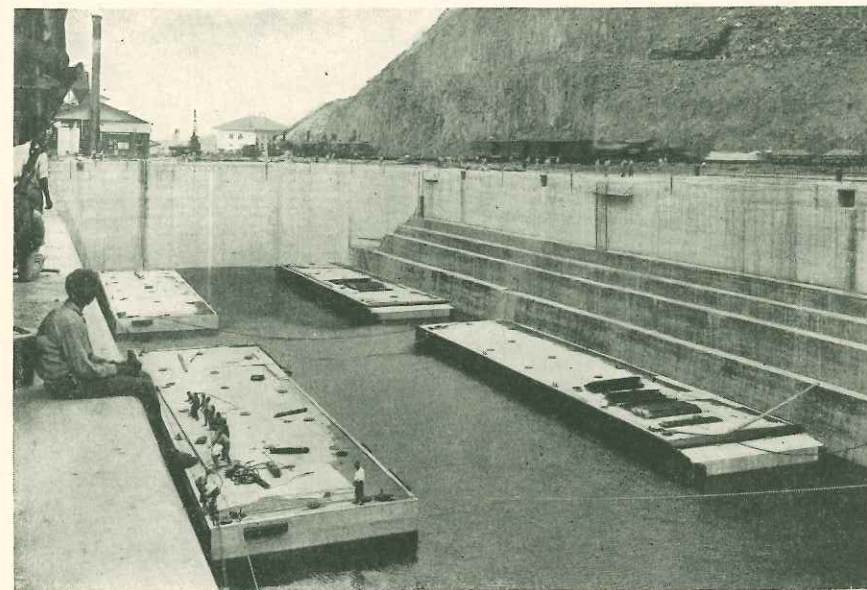
More than ordinary speed in construction is made possible because the skeleton of reinforcement may be placed quickly and the ship launched as soon as the hull has been finished far enough to float the unloaded vessel.

Sand, stone, cement, steel reinforcing bars and structural steel shapes are on the market and usually may be obtained promptly. Therefore, the materials required for concrete ship construction are generally and readily available.

Most of the labor necessary to build concrete ships is of the cheaper grade. Expert supervision is needed with any ship construction, but the number of skilled artisans required for concrete shipbuilding is small.

Calking, heavy framework and bracing, fitting of plates, and shaping of planking are entirely eliminated in concrete ship construction.

As the time required to construct a sufficient portion of the hull to permit floating the vessel is very short because of the speed with which concrete may be placed, it is possible to make use of dry-dock facilities, allowing the vessel to float as soon as possible and then to bring up materials on scows and barges, thereby materially lessening the amount of handling of materials and increasing speed of construction.



Finished concrete pontoons on Panama Canal, floating in dry dock.

CONCRETE BOATS AND BARGES NOW BEING BUILT

As will be seen from the following examples of boats and barges now finished or under construction, the practicability of concrete for such structures is not questioned by those familiar with its possibilities.

Concrete may be applied to or used in connection with the reinforcing framework of the hull by either of two methods:

- (1) Mixed and then placed in forms in the same manner as in the construction of buildings, etc.
- (2) Applied by means of a machine such as the Cement

Gun or similar apparatus, using compressed air or steam under pressure. In such cases fewer and simpler forms are required.

CONCRETE BOAT BUILDING AT MONTREAL

There is now (November, 1917) under construction at Montreal a 125-foot, single-screw steamer having structural steel ribs and keel and a hull of reinforced concrete. This vessel has a beam of 22 feet and a depth of 13 feet. The concrete shell varies in thickness from 3 to 5 inches between ribs, which are 27 inches apart. This boat is intended for service on the Lakes and was launched November 14. Elsewhere in this booklet are pictures illustrating various stages of its construction. The boat is being built by the Atlas Construction Co., Ltd., 37 Belmont Street, Montreal.

LARGE OCEAN-GOING CARGO VESSEL UNDER CONSTRUCTION AT REDWOOD CITY, CALIFORNIA

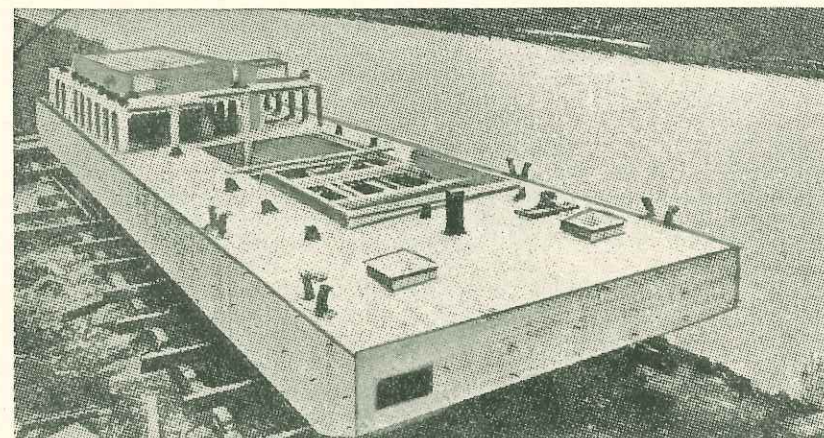
Early in 1917 a group of San Francisco capitalists formed the San Francisco Shipbuilding Co., to undertake the construction of seagoing vessels of concrete. The company is now building an ocean-going cargo vessel of nearly 5,000 tons, that will be about 330 feet long and 46-foot beam. In constructing this vessel the reinforcement was welded together, thus reducing to a minimum the quantity of steel required, by avoiding laps that otherwise would have been necessary. Plans for this work were developed by Allan McDonald, of McDonald & Kahn, San Francisco. The original drawings indicated that the reinforcement used weighs less than the bolts needed in a wood ship of equal dimensions, and that the hull will weigh less than that of a wood ship. 2500-horse power turbine engines equipped with reduction gears will be used as motive power. Progress in the construction of this, the largest concrete vessel yet to be built, has recently been shown at motion picture theaters throughout the country in the Hearst-Pathe Weekly. It is expected that work will be finished and the vessel launched early in 1918. An illustration in this booklet proves that this will be in every sense of the word, a ship.

200-TON SEAGOING BARGE BUILT IN NORWAY

In August there was launched at the plant of the Porsgrund Cement Casting Works, Porsgrund, Norway, a 200-ton motor lighter. During July, 1917, Jens Hauland, Vice-President and General Manager of the plant mentioned, was in the United States exhibiting a 9-foot model of a boat built

according to the plans that the company followed in building the 200-ton lighter. The 9-foot model was turned over to the United States Bureau of Standards so it could study the methods of construction. When Mr. Hauland was in this country he said that companies had been formed in Bergen, Norway, and Buenos Aires, South America, to build concrete vessels after the same plans his company is using. Elsewhere is reproduced a photograph of the 9-foot model which was turned over to the Bureau of Standards, also a drawing showing some of the features of construction and design.

The Porsgrund plant builds these boats bottom up, an internal mold being used which is made in units that can readily be taken apart and reassembled. Such a vessel is launched in the same position in which it

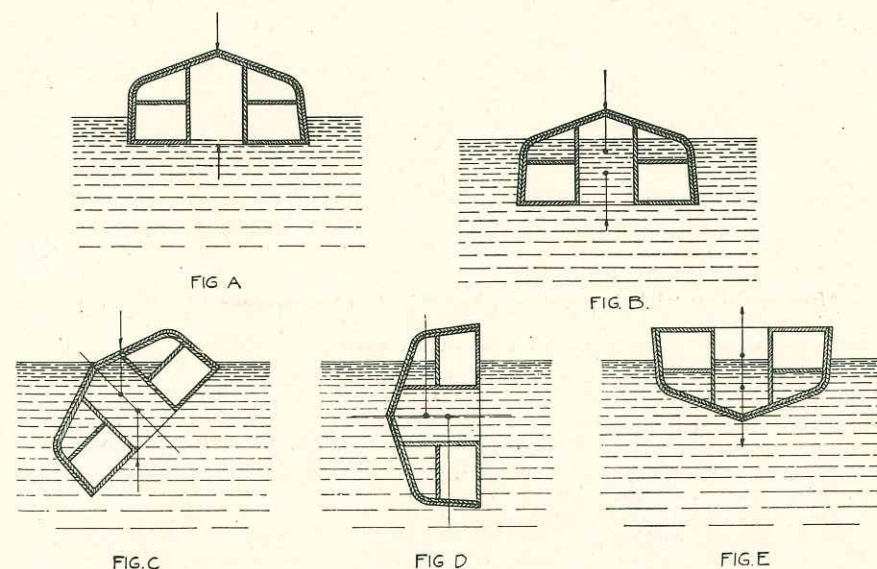


Concrete pontoon built for the Manchester Ship Canal Co., England, by the Yorkshire Hennebique Contracting Co., Ltd., Leeds, England.

is built — bottom up — and by taking advantage through special arrangement of interior compartments, a small amount of water is admitted so that the vessel soon after being launched rights itself. The general structure of the vessels is a series of transverse ribs with a thin shell, and because of the fact that it is cast bottom side up, it is easier to control the density of the concrete along the bottom and lower side of the hull; consequently thinner sections can be used than might otherwise be possible.

The launching of this 200-ton lighter was briefly referred to in a Norwegian paper of August 22 as follows:

The launching was done after heretofore unknown methods, namely by letting the ship go into the water bottom up. This method was yesterday tried out for the first time after calculations by the cement works superintendent, Engineer Alfson. The launching was a great success in every respect and came out exactly as calculated. The barge of 200 tons capacity used about 15 to 20 minutes to right itself.



Diagrams illustrating the principles of launching boats, bottom up, as practiced by the concrete shipbuilding plant at Porsgrund, Norway. This diagram shows how water is admitted to certain parts or compartments, thus introducing a lack of stability which causes the boat to slowly right itself after launching.

A series of photographs reproduced in this booklet illustrates several stages of the launching. *Shipping* (New York) of November 3 illustrated by the above sketches, A, B, C, D and E, the principles of launching, which were described as follows:

The diagram A represents a section of the vessel immediately on taking the water. The inner mold divided into compartments is seen, together with the outer reinforced concrete hull of the vessel, and it will be observed that as yet there is no water in the middle compartment of the mold owing to the air not escaping rapidly enough through the vent pipes. As the air escapes, however, the water rises in this compartment, the vessel gradually sinking as it loses its buoyancy, until the water reaches the level of the two upper side compartments which are also gradually flooded, so that a position is gradually reached as shown at B when the vessel is submerged to its maximum amount. The lower side compartments are never flooded, and thus the vessel is in a state of unstable equilibrium, the center of gravity being considerably higher than the center of buoyancy as shown. If now from any cause whatever the vessel heels to one side or the other, the weight of the hull and its contents acting through the center of gravity and the pressure on the submerged area acting through the center of buoyancy, form a couple, the moment of which tends to turn the vessel on a longitudinal axis as shown at C. The moment of this couple has its maximum value when the vessel is in the position shown at D, after which it gets gradually less and less until the vessel floats in the correct position as shown at E, when the moment of the couple is again zero, but the vessel is now in a state of stable equilibrium. The slightest list to one side or the other after the vessel has been launched and the compartments filled is thus sufficient to cause her gradually to heel completely over until she floats in a normal position. The flooded compartments are then pumped out, and the mould is removed, this being used again in the construction of another similar vessel.

The general plans and some details of this lighter are shown in the sketches on pages 26 and 27.

400-TON CARGO VESSEL AT MOSS, NORWAY

On the cover of this booklet is reproduced a photograph of a 400-ton concrete vessel built by Fougner's Steel Concrete Shipbuilding Co., of Moss, Norway, for ocean service. This boat also is a product of 1917. Herman Fougner, Civil Engineer, 110 West 40th Street, New York, and brother of Nic K. Fougner, Managing Director of the Fougner Steel Concrete Shipbuilding Co., in a letter written to the Portland Cement Association, November 3, says:

After extensive trials in rough weather, this ship has received Lloyds' class. The approximate displacement of this boat is 400 tons. It is driven by a Diesel engine and carries enough oil fuel for a trip from Norway to England and return.

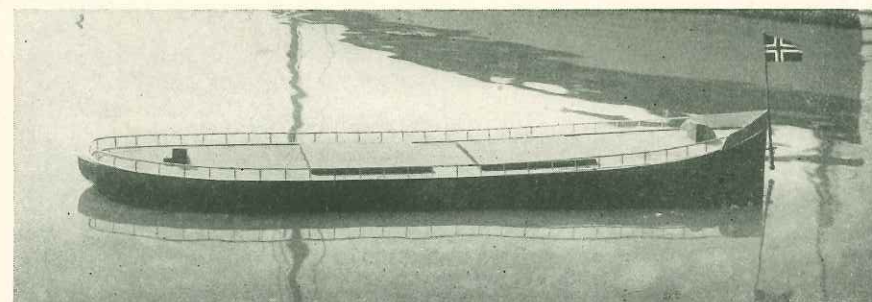
Last summer there appeared in the *Norwegian Shipping Gazette* an advertisement, the translation of which was as follows:

Fougner's Steel Concrete Shipbuilding Company. Lighters of steel concrete 100 tons dead weight can be delivered in from 6 to 8 weeks. Seaworthy motor ships about 200 tons dead weight can be delivered in from 3 to 4 months. Larger lighters and motor ships up to 3,000 to 4,000 tons dead weight for delivery the first half of next year. Building of floating dry docks can be contracted for the latter half of 1917.

Reference to the work described in the foregoing advertisement was made in a report of the American Consul-General at Christiania. The following, quoted from that report:

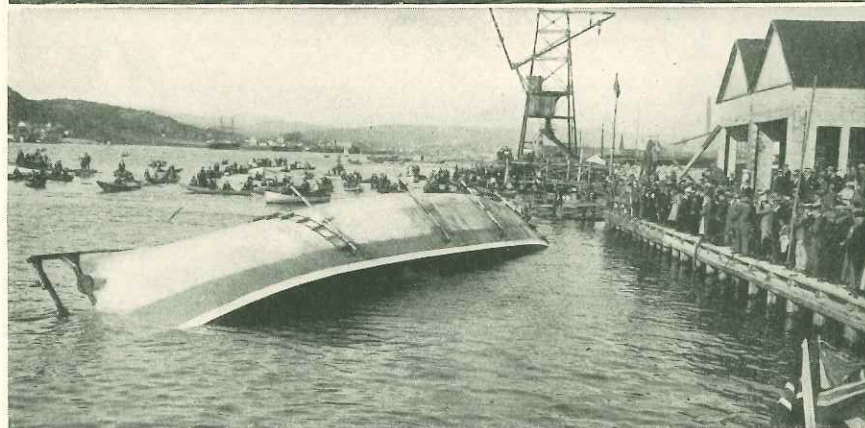
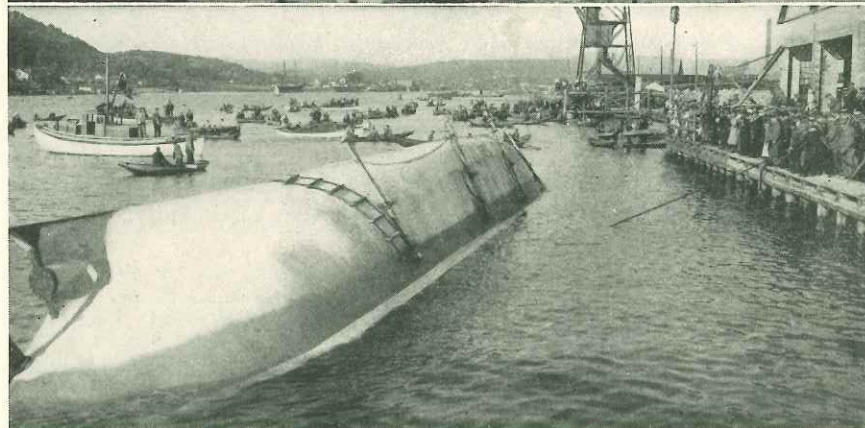
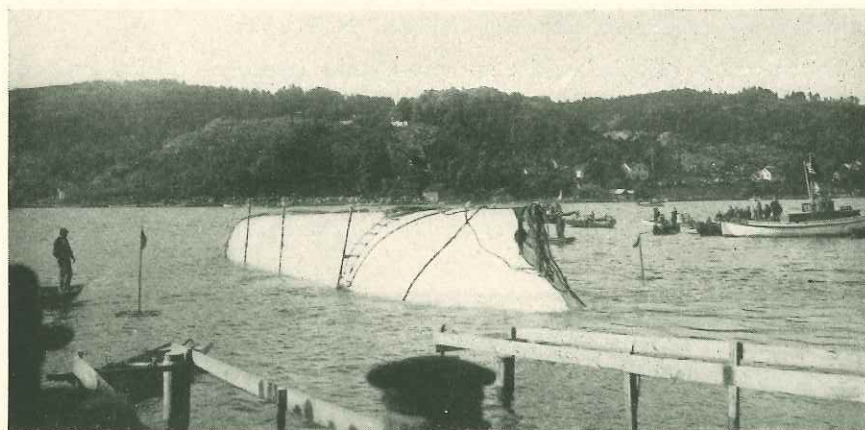
The inventor of this new style of vessel is said to be M. Nicolai Fougner, an engineer, who claims to be able to construct a ship of any size demanded. He is now building a lighter for a mining company at Sydvaranger for the oversea export of iron ore and the import of coal. The vessel, having a displacement of 3,000 tons, is to be ready before the end of the current year, 1917. It is stated that these concrete ships can be sailed or engine like other vessels, and experts consider that a new epoch in shipbuilding has arrived.

The ship, which arrived in Christiania last month, resembles a large barge, and is constructed entirely of concrete with the exception of the ribs, which are of steel. This



Nine-foot model of concrete boat built by Concrete Products Plant at Porsgrund, Norway. This model was turned over to the United States Bureau of Standards, July, 1917, to enable it to study the methods of construction. The Company which built this boat is now turning out concrete vessels of 200 tons capacity.

CONCRETE SHIPS



These views with those on the opposite side show the launching and

CONCRETE SHIPS



self-righting of the 200 ton concrete barge referred to on preceding pages.

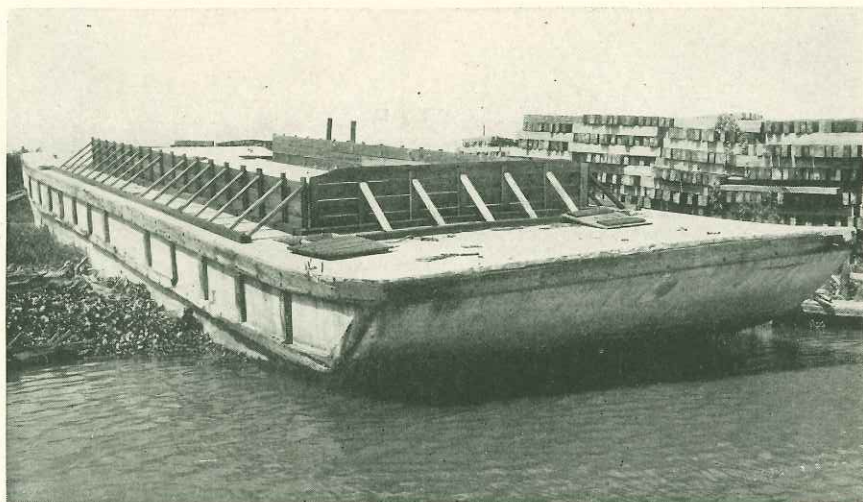
new method of constructing ships has attracted much attention. The Swedish Minister of Marine, M. Brostrom, one of Sweden's largest shipowners, immediately ordered a lighter of some thousand tons displacement, and he was present when the craft was launched at Moss. He was accompanied by four experts, all of whom expressed much satisfaction at the result.

Two other lighters are now on the stocks, and a large ship for a 4,000-ton craft is nearly completed. More than 200 men are now working in the new yards, and five lighters have been contracted for in addition to the one completed and the two on the slips.

In June, 1917, the following news item appeared in *Motorship* (Seattle):

3000-TON DIESEL MOTORSHIP OF FERRO-CONCRETE

There is due for delivery in July, the first large motorship of ferro-concrete construction, which now is on order for the Sydvaranger Mine Co., of Norway, and will be used for carrying iron ore across the North Sea. She is of 3,000 tons and is being equipped with two direct-reversible Polar-Diesel engines, each of 300 b. h. p. Her builders are the Fougner's Staalbeton Skibsbyggnings Co., of Moss, Norway, who will build semi-concrete hulls up to 5,000 tons per ship.



Concrete barge of the Gabellini type, built at Mobile, Ala., and described elsewhere in this booklet. Length 90 feet, beam 26 feet, depth 9 feet. This barge was washed ashore during a severe gulf storm some time ago and is shortly to be again floated.

In the *Scientific American* of November 17 is an illustrated article giving late data relative to concrete shipbuilding now being done at the Fougner plant, Moss, Norway. The following is taken from the article mentioned:

The first vessel undertaken at the yard was started in June of 1916, and by the beginning of 1917 the establishment had built and launched a matter of 15 craft. Most of these were barges for coastwise towing, and it was not until a few weeks ago that the 'Namsenfjord' was ready for service. The earlier boats enabled the company to feel its way in perfecting the methods now standardized, and today the yard has on the

blocks one ship of 4,000 tons well advanced, and four others begun — three of 1,600 and one of 1,000 tons, all of which will be driven by Diesel engines of the Bolinder type.

The same company is also constructing a lightship of reinforced concrete for the Norwegian Government, and when this vessel is ready she will be stationed in the stormy sweep of the Skagerak. The yard is building, besides, a big tugboat of the same material, and has already turned out a granolithic floating drydock having a lifting capacity of 75 tons. Based upon the experience gained in this case, the concern is now about to undertake two other floating docks of ferro-concrete each capable of handling ships of 7,000 tons displacement. These various adaptations of reinforced concrete illustrate the wide range of applicability of this material in the different departments of marine architecture.

CONCRETE BARGE BUILDING NEAR NEW YORK

The Louis L. Brown Co., 30 Church Street, New York, is building a barge 112 feet long, 33 feet beam, and 10 feet deep. When light, this will have a draft of 3 feet 4 inches. Its carrying capacity is 700 tons. Photographs reproduced elsewhere illustrate certain stages of its construction.

The following data were supplied by Mr. Brown, of the company mentioned:

The frame consists of reinforced concrete members in which deformed rods are used as reinforcement. The shell is reinforced with wire mesh. Concrete is to be waterproof in itself by proper proportioning, mixing and placing. The rail, bulkheads and deckhouse are also of concrete, the only wood used being that for the fender, wales and gunwales. This barge will have all the usual fittings common to floating structures of its kind and is intended for use in the harbors and inland waters.

This barge was nearing completion at the time this booklet was written.

The Louis L. Brown Co. is prepared to build concrete barges of all kinds and has made designs for several types of barges other than the one described. The company has a number of orders on its books for concrete barges and is proceeding with their construction.

CONCRETE SHIPS BUILDING IN FRANCE AND ENGLAND

An article by David Pollock, M. I. N. A., that appeared in *The Merchant Service Review* and *R. N. R. Gazette* (Liverpool) during November, 1917, contains the following interesting information as to what is now being done abroad to solve the shipping problem with concrete:

Notwithstanding Britain's backwardness in seriously recognizing or taking up the construction of reinforced concrete vessels, there are now designed and actually being constructed, on lines as to size and destined uses, 'ship-shape' vessels which show that experts in the requirements of given classes of shipping, as well as practical shipbuilders, are quite convinced of the reality of the claims which reinforced concrete now proffers for an established position as shipbuilding material. Apart from the fact that there are orders on hand from the French Government for ferro-concrete barges to the extent of hundreds, and that our own Government departments are expected shortly to follow suit, private enterprise is now entering upon paths which will, no doubt, lead

to concrete construction for the larger and more regular types of ships. For example, Messrs. James Pollock, Sons & Co., Ltd., naval architects and engineers, London, are about to commence the construction — owing to their inability in the present circumstances to build them of steel or of wood — of several coasting vessels for their fleet of Miramar Motor Coasters. The first vessel to be laid down has a length of 92 ft., breadth 19 ft., depth 10 ft., and will be self-propelled (barges which are towed are, of course, a simpler proposition) by an internal combustion engine of the Bolinder type of 120 brake horse-power.

Several Scandinavian shipyards have been laid down exclusively for building concrete vessels, and a number of 200-ton lighters are already in commission. There has been completed and successfully tried for speed and other qualities, by the A. S. Fougner's firm at Moss, Norway, a reinforced concrete vessel 84 ft. in length, 20 ft. beam and 11 ft. 6 in. deep, intended for the North Sea timber trade. The vessel is driven by Bolinder Motor at $7\frac{1}{2}$ knots speed and carries 300 tons cargo. At this Norwegian firm's works also two reinforced concrete ships are being built for the North Sea trade, one of 1,000 tons and the other of 600 tons capacity, the latter being 125 ft. long and will be fitted with a 250 horse-power motor engine using crude oil. Another sea-going steamer of 3,000 tons is also in hand. One Danish firm alone has had as many as ten types, varying from 300 to 1,000 tons d. w., approved and classified by the Bureau Veritas for overseas work. It has been seriously proposed, and designs have been prepared, to build mammoth concrete craft of 15,000 to 20,000 tons to serve as train ferries between Gothenberg and this country. Designs have been prepared by a San Francisco firm of engineers for a reinforced steamship 330 ft. in length, 44 ft. beam, and 31 ft. depth, having a capacity of 4,500 tons.

Rapidity and ease of construction, as well as cheapness, are strong points in favor of reinforced concrete ships, especially so, of course, in the present condition of shortage of ships and steel shipbuilding material. There need be no waiting for materials: sand and stone are always and everywhere available, large quantities of cement are constantly in store, and steel rods and mesh work are kept in stock by merchants and manufacturers. A ship can be commenced as soon as the plans are completed, and no delays need be incurred through having to order and await delivery of specially shaped and prepared structural items.

In the April, 1917, issue of *Concrete and Contructional Engineering* (London) mention was made that a company had been formed in Paris, to be known as Le Matériel Flottant, for the purpose of building seagoing lighters and similar floating concrete structures. The July issue of the same magazine contains reproductions of several photographs, among which was an illustration of a reinforced concrete ship in course of construction on the Paris Ship Canal. Views of this boat in process of construction are given elsewhere. Further mention of this work appeared in the principal daily papers in a press item sent from Paris, July 31. In this item, Anatole de Monzie, Under Secretary for Sea Transportation in Merchant Marine, France, was quoted as saying that two of these concrete boats or lighters were already in service. Reports have appeared in the press at various times since to the effect that numbers of such boats or barges were in use and being built for the transport of munitions and other war supplies on the French waterways.

Early Examples of Concrete Boats

CONCRETE BOATS ORIGINATED IN FRANCE

But few persons are perhaps aware of the fact that the first example of what today would be called reinforced concrete was a boat. In 1849 there was built by M. Lambot, of Carces, France, a rowboat which was nothing more nor less than reinforced concrete. This piece of work marked the starting point of the history, not only of concrete boatbuilding but of reinforced concrete. The process of construction was patented and its maker exhibited his work at a world's fair held in Paris in 1855. It is said that this boat is still in service. M. Lambot's work was investigated by the French Government in 1850 but, as is often the case, further development was left to private initiative.

CONCRETE SHIPS IN ROME

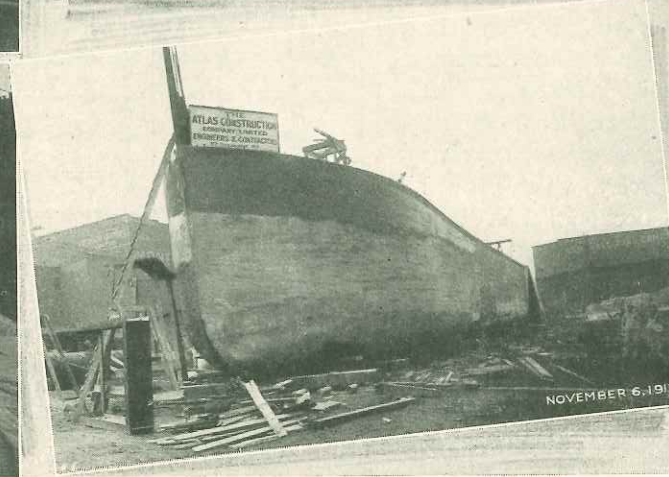
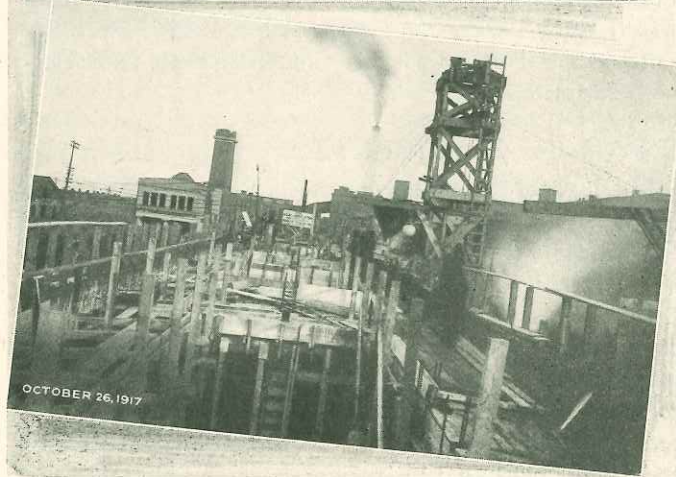
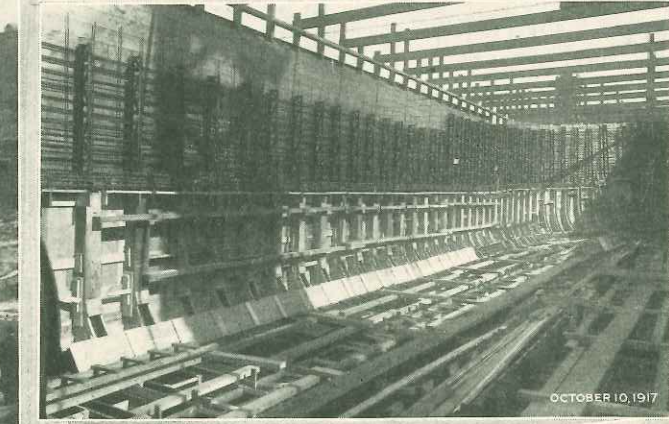
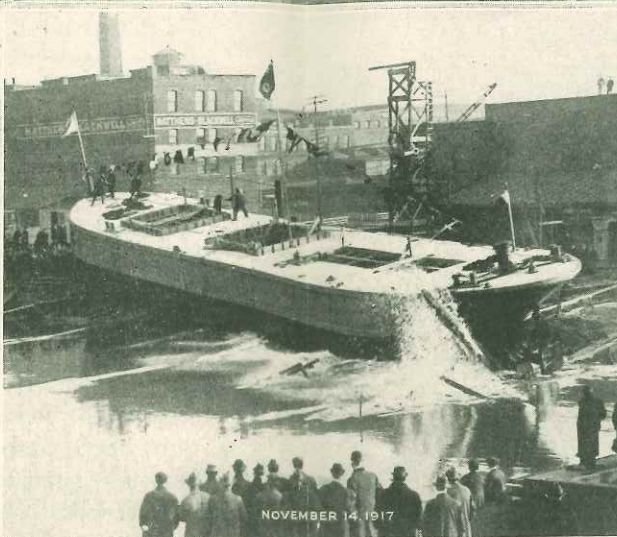
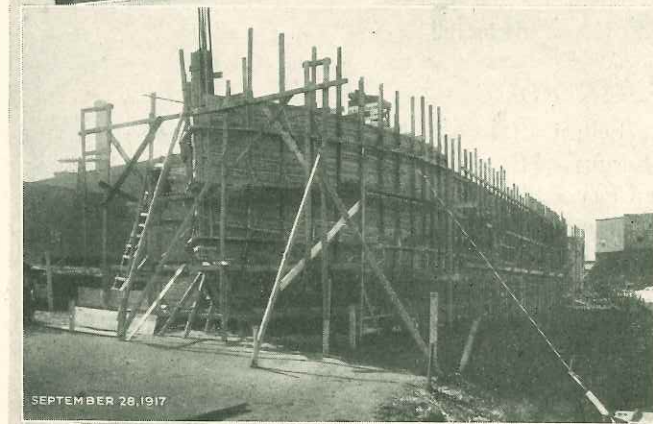
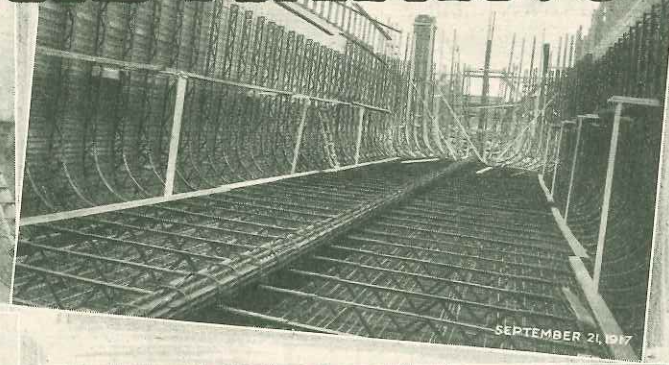
In 1899, Carlo Gabellini, of Rome, Italy, began the construction of concrete scows and barges. His process had been so developed by 1905 that a 150-ton barge was constructed for the city of Civita Vecchia. The following year another barge was built for the military harbor at Spezzia, for use of the Italian navy. This latter barge before acceptance was put to the severe test of being driven against some piling and afterward being rammed by a steel towboat. Results of these tests were so satisfactory that construction of similar boats or barges followed.

In 1909, a special representative of *Beton u. Eisen*, a Berlin publication, visited the works of Gabellini and made a detailed report of the methods by which these barges were constructed. As these differ considerably from methods which up to this time had been used elsewhere, they deserve description.

GABELLINI METHOD OF CONSTRUCTION

The first step in "laying down" these vessels consists of placing reinforcement for the keel and ribs. This reinforcement, which usually consists of round steel rods, is then covered on the outside with $\frac{1}{4}$ -inch wire mesh, to which a 1-inch coat of cement mortar is applied by hand. Next, a somewhat thinner coat of mortar is placed on the inside, following which forms for the ribs and keel are put in place and concrete deposited for these parts of the vessel. These ribs run both longitudinally and transversely so that a checkerboard arrangement results, the pockets being 10 inches deep and the ribs about 2 inches wide. Over these ribs $\frac{1}{8}$ -inch wire mesh is placed with a thin mortar covering plastered on. Finally a third and coarser wire mesh is pressed into the soft mortar

A CONCRETE SHIP IN THE MAKING



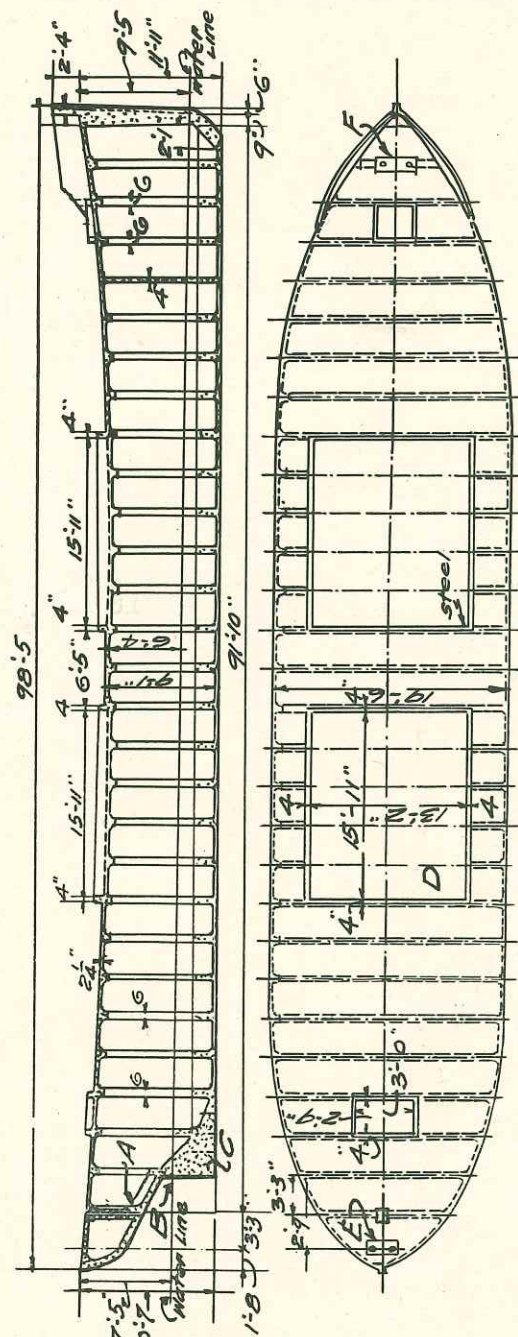
Views showing progress in construction of the concrete ship built by the Atlas Construction Co., Ltd., Montreal. These views are arranged from left to right in the order of progress of the work, with the exception of the center view, which is from a photograph by Underwood & Underwood, showing the launching of the ship.

and the entire surface troweled over. This completes the hull. Bulkheads are next concreted and the boat finished with a wooden sheer strake and gunwale.

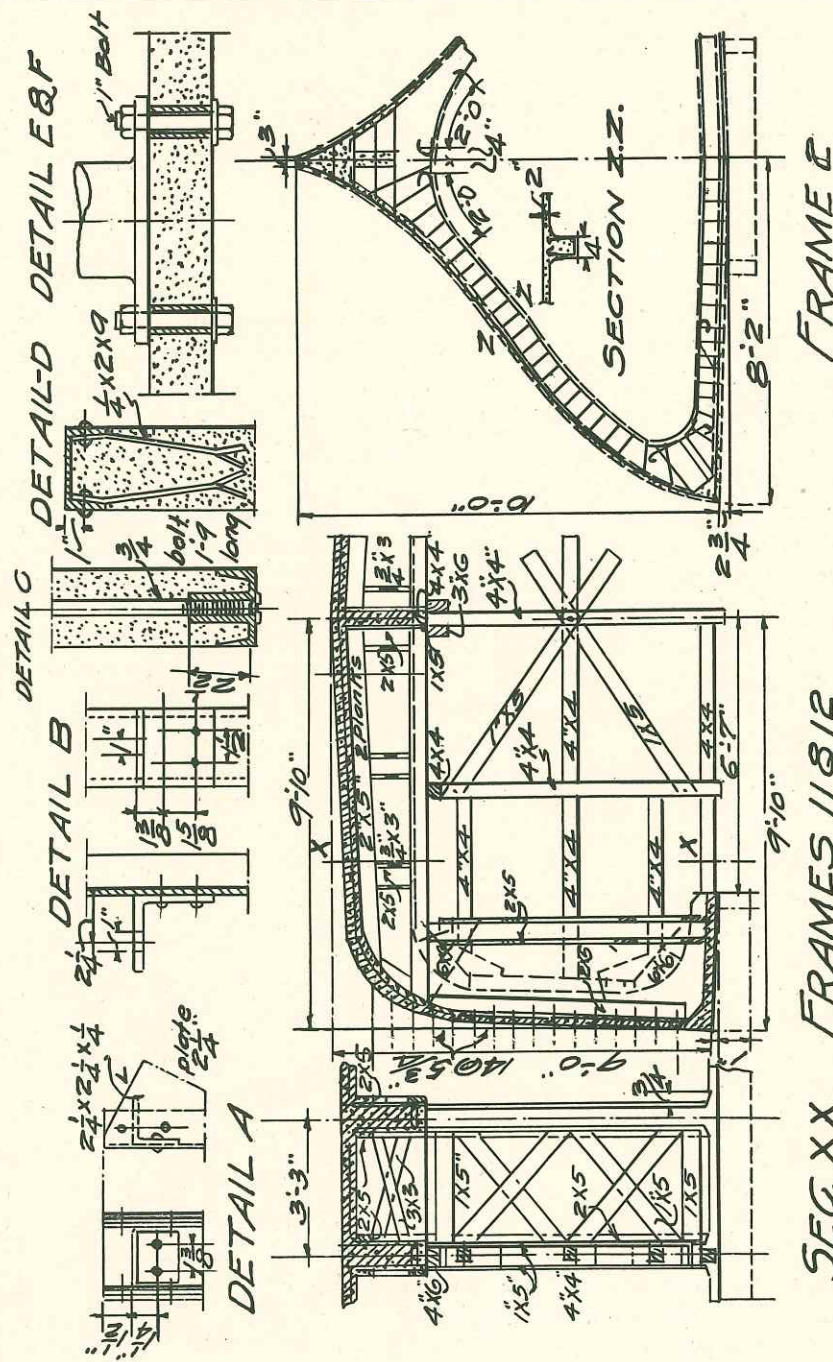
At the time this inspection of the Gabelini yards was made, there were in process of construction several railroad car ferry floats large enough to carry six coaches. These floats were intended for use at the railroad ferry in Venice. They were designed to take rails 154 feet long.

CONCRETE SHIPS IN HOLLAND

The first concrete boat in Holland was built in 1887 by the Fabriek van Cement-Ijzer Werken. This concern first built barges up to 11 tons capacity, which proved so successful that plans were elaborated resulting in the building of barges 64 feet long and 14 feet beam, of 55 tons capacity. Briefly, the system of construction consisted of building longitudinal and transverse bulkheads spaced



General plan of 200-ton reinforced concrete lighter launched August, 1917, at Porsgrund, Norway.



SEC. XX FRAMES 11 & 12

FRAME 2

Framing details of 200-ton concrete lighter launched August, 1917, at Porsgrund, Norway.

approximately on 6-foot centers, thus providing a cellular construction which made the ship practically unsinkable.

Of interest also is some work done by R. Last & Sons, a concrete firm in Holland, who built a motorboat in which a framework of steel ribs and longitudinal rods, to which wire mesh was attached, was covered with a coat of mortar. This finished shell was but $\frac{1}{2}$ inch thick. The boat had room for six or eight people and was propelled by a motor which drove it at moderate speed. However, the boat was intended only for pleasure purposes.

GERMAN CONCRETE BOATS

Following precedent established by the Dutch, German shipbuilders constructed, in 1909, at Frankfort-on-the-Main, a concrete freighter of 220 tons. This boat was built by the Allgemeine Verbundbaugesellschaft, simple forms being set up and concrete placed between them. The result was a boat, the main hull of which had parallel sides, yet elsewhere a shape with fairly good lines so that the water resistance was decreased below that of a rectangular barge. Rectangular compartments forming watertight bulkheads similar to those used by the Dutch were a feature of construction. A small after cabin completed the vessel.

In 1912, Herr Johannes Lescher, of Dresden, conceived the idea of building a concrete sailboat. His design embodied the latest principles of sailing vessel construction as to shape of hull and method of computing construction. Designs were worked out for three conditions — floating in disturbed water; to withstand lifting with a single crane; and to rest on its keel on dry land, filled with water. This boat was launched in April, 1912, and in spite of frequent groundings gave excellent service for nine months following its completion. Its present condition, for obvious reasons, cannot be determined.

NEW SOUTH WALES USES CONCRETE PONTOON

In 1914, the Sydney Harbor Trust decided to build a pontoon for use in Circular Quay, Sydney, N. S. W. After investigating various available methods of construction, decision was reached to use reinforced concrete as it seemed likely this material would eventually prove cheapest because of durability and low maintenance. This pontoon is 110 feet long, 53 feet 3 inches wide at the bow, 67 feet 7 inches at the stern, has a draft of 7 feet 9 inches and deck area of 6,000 square feet. The total displacement is 783 tons. 342 cubic yards of concrete and 43 tons of reinforcing steel were used in its construction. The bottom of this barge is 5 inches thick. Bulkheads 4 inches thick divide the whole into 44 compartments, which support an 8-inch concrete floor, or deck.

CONCRETE BARGES ON THE MANCHESTER SHIP CANAL

A 100 by 28-foot concrete barge built to carry sludge pumps, boilers and fuel for use on the Manchester Ship Canal, England, has been found extremely economical. This was built by the Yorkshire Hennebique Contracting Co., Ltd., Leeds, England. Its cost was low, and maintenance on it has been found less than on similar barges of other types of construction. Experience has proved that no interruption in its service is necessary, as such repairs as may be needed can be made without dry-docking. Bottom and walls of this barge are 3 inches thick except under the boiler room and coal bunkers, where they are 4 inches thick.

CONCRETE BARGE ON WELLAND CANAL PUT TO SEVERE TESTS

That concrete barges can successfully withstand rough usage is well illustrated by experience with a concrete barge in use on the Welland Canal, Canada. This was launched November 9, 1910, since which time it has been used principally to carry stone. The barge measures 80 by 24 and has a draft of 7 feet. At times whole carloads of stone from dump cars were dropped upon its deck from a 12-foot trestle, without injury. An article in *Engineering News*, New York, of January 4, 1915, called attention to the satisfactory service which this boat had given for four years. This period was sufficient to reveal defects, had there been any. The fact that no serious ones were disclosed should prove beyond question that concrete barges are a success.



Concrete motor cruiser, Wanderer, owned by Ivan Widing, Sabin Hill Yacht Club, Dorchester, Mass. This boat was built and fitted up with a view to use for taking motion pictures.

CONCRETE BARGES ON THE PANAMA CANAL

Concrete barges built on the Panama Canal in 1911 proved good examples of what service such barges could render under adverse conditions. In this case concrete was selected as the construction material because no skilled labor for steel or wood ship construction was available, nor could steel plates nor suitable seasoned timber be obtained within the time

required. Concreting materials were at hand in large quantity and the expediency of using concrete suggested itself as a happy solution of the problem.

The design of these barges called for a structure 64 feet long by 24 feet wide, with a depth ranging from 5 feet 4 inches to 5 feet 8 inches. Walls were made 2½ inches thick because the barges were intended for use merely as floats to carry suction pumps and engines. The only bracing of the hull consisted of two 3-inch bulkheads extending from bow to stern. Reinforcing consisted of ½-inch square deformed bars covered with ½-inch No. 12 wire mesh. Reinforcing was suspended in place from wooden beams and properly located by constructing a wooden platform placed at an elevation corresponding to the bottom of the barges. Bars were placed on 9-inch centers lengthwise, and 12-inch centers crosswise, after which the platform was removed and the network of reinforcing covered with wire mesh. A ½-inch coat of cement mortar was then applied to the wire mesh. Ten running feet of the barge length for its entire width was built up at one time.

CONCRETE PONTOONS, ZURICH YACHT CLUB, ZURICH, SWITZERLAND

Engineering News-Record, November 1, 1917, reports the construction of a floating dock on concrete pontoons for the Zurich Yacht Club, Zurich, Switzerland. This structure was made necessary because of periodical variations in lake level. The dock was made of six reinforced concrete pontoons 13.1 by 37.4 feet in plan, each being covered with a reinforced concrete slab. The pontoons were constructed on shore, supported on two sets of skids. The walls are 2½ inches thick, while the deck slab is 3¼ inches. These structures have been in satisfactory service for about 1½ years.

CONCRETE BARGE BUILT AT MOBILE

On June 14, 1912, there was launched at Mobile (Ala.) a concrete barge 90 feet long, 26 feet wide and 9 feet deep. A number of papers at the time gave considerable publicity to this work, generally describing it as the first work of its kind in the United States. The Gabellini system of construction was used, the work being done by Luigi Volpi, an Italian engineer who acquired his experience in the use of concrete for barges while connected with Gabellini's organization in Rome.

There seems to have been little or no mention of this barge after completed, but during a storm which swept the shores of Mobile Bay in 1916, the barge was washed about 300 feet inland. Owing to the fact that ownership of the barge was divided among several persons in this country

and in Italy, nothing has been done to repair a small hole that was broken in one side due to striking a sunken pile when it was washed ashore, therefore it has not again been floated. An illustration of this barge is reproduced in this booklet.

A CONCRETE BOAT IN CENTRAL AMERICA

During the summer of 1917, the following letter appeared on the editorial page of the *New York Sun*:

To the Editor of the Sun — Sir: Referring to the interesting article on wooden ships in *The Sun* of Sunday, June 10, I should like to ask American genius, "What's the matter with building cheap hulls of reinforced concrete?" I have built a light serviceable boat of that material.

P. P. Brannon,
Sonsonate, Salvador.

Thinking that the writer of the letter might be able to give interesting information regarding the construction of concrete boats, the Portland Cement Association communicated with him and received the following entertaining and informative reply:

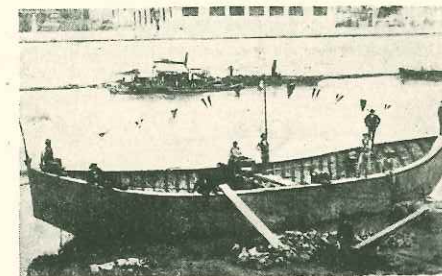
Your cable dated yesterday regarding the reinforced concrete boat reached me last midnight and I proceed to explain.

The rowboat myself and my 'prospecting pard' built years since, if still afloat, is thousands of miles from this place, and 'from nowhere,' and consequently I am unable to furnish photographs, but I will endeavor to furnish you with a pen-picture of its construction, hoping thereby, as age prevents my absence on the firing line in France, to thus indirectly get a crack at the Kaiser and his cattle in the name of democracy, and incidentally to aid our beloved Uncle by boosting his cement business. I am an American first, last and all the time, and personally have 'no ax to grind.'

Employed with my aforesaid 'pard' to 'hold down' the scattering supplies and loose property of a busted mining company back in the 90's, we found ourselves with any number of barrels of cement and several tons of woven wire screen sheets, plus other mining plunder, and all the unoccupied time the Lord was then making on our hands, and when we became so thoroughly tired of too much rest that we were becoming quarrelsome we proceeded to 'do things.'

Experiments with cement and woven wire in the building of a bathtub, horse troughs, and an 'American cooking-stove' convinced us that what we didn't know about Portland cement, if written out, would make a much larger book than Webster's dictionary and, contrary to Joe's — my pard's — convictions profanely expressed whenever anything hitched in the proceedings he knew the d—d thing would go to the bottom like a kedge anchor, and was continually kicking about our wasting so much 'valuable' time, we proceeded to build of stone the first boat of that material, possibly, that ever floated on water.

We decided to build the boat keel up and I made up drawings on such basis. We prepared a cemented building floor curved to the lines of the craft's gun'als, marked on this floor the center and interior lines of the boat and to such lines built up with a

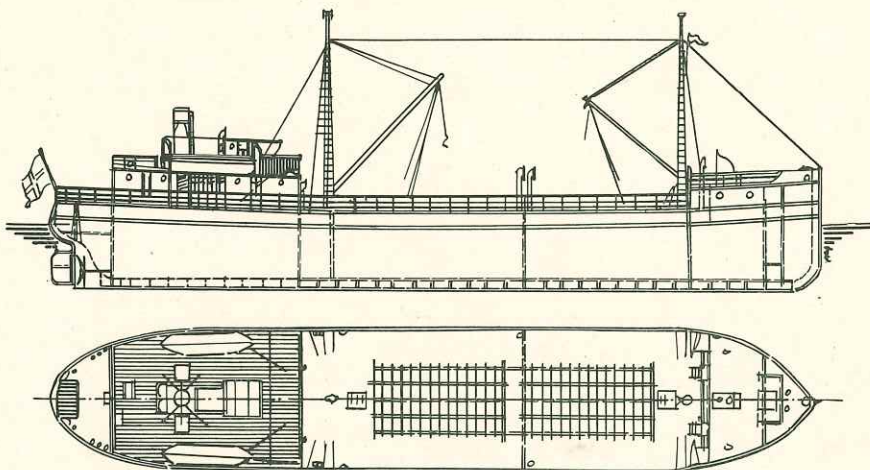


Reinforced concrete boat "Liguria," Built by Carlo Gabellini, Rome, Italy.

CONCRETE SHIPS

suitable mixture of clay and sand a solid 'core' of the exact interior size and shape of the boat to be.

To fit such core as exactly as possible we then built a skeleton boat of the heavy woven screen wire, joining the sheets solidly with copper rivets and wire and fitted same over the core described, loosely, which we had previously plastered with a $\frac{1}{2}$ -in. coat of wood ashes to prevent adhesion of the cement. Our wire was quite stiff and heavy but easily workable to shape by hand and mallet and of about a $\frac{1}{2}$ -in. mesh. Outside of this mesh, as we troweled in the concrete — a 1 to 1 mixture of cement and clean river sand — we built as we went along a retaining dam or shell of damp clay to hold our concrete in place, calculating as nearly as possible a uniform thickness of an inch, excepting on the bottom where we gave the job a thickness of nearer 2 inches.



Plan and sectional view of 1000-ton reinforced concrete motorship built during the summer of 1917 by Fougner's Steel Concrete Shipbuilding Co., Moss, Norway. Length 166 feet, beam 31 feet, molded depth 18 feet. Power is to be supplied by two 160-horsepower crude oil burning motors.

Our concrete was sloppy but not too much so to trowel, or too little so to pour, but the craft was not poured.

We put her in the lake after about a month's wait and to Joe's chagrin, she floated O. K.; lopsided and down at the stern, 'twas true, but she floated. Our nigger's verdict was 'fo' de Lord, dem is de crazyestes whites folks I ebber sawed.'

Joe became at once an enthusiastic marine architect, hewing that old tub with a hatchet until the wire showed in spots and she rode an even keel much too high out of the water. I discovered that, owing to the continual guying with 'she'll sink like an anchor,' I had been frightened into building her one-half to a foot too deep. She was, strange to say, springy under foot as a wooden boat and once under way as speedy as the Indian canoes.

We built a second and much better boat — 18-footer — that we continually used with oar and sail until we were forced to leave that howling wilderness owing to a dearth of canned goods — our only legal tender with the natives — our company having forgotten its mine, us and our \$10 per day as caretakers. This second boat was a James Dandy. You will note our boat was built without frames, a system which, of course, would not work out with large craft.

I believe 10,000-ton steamers of uniform dimensions can be turned out at one-fourth the cost of wooden ships by the system of reinforced concrete construction, and much faster than Uncle Sam can put the engines in them.

Tell your engineers to get their think boxes tuned up on this proposition if they wish to cut a swath in future history.

(Signed) P. P. Brannon.

CONCRETE SHIPS

CONCRETE BARGES AT BALTIMORE

While Harbor Engineer of Baltimore, Oscar F. Lackey developed and patented a system of concrete barge construction which, in 1912, was applied to building a concrete scow for the Arundel Sand & Gravel Co., of that city. This craft has a length of 113 feet, a beam of 29 feet, and a depth of 10 feet 6 inches.

ARUNDEL SAND AND GRAVEL COMPANY

FRANK A. FOSTER, PRESIDENT
JOSEPH J. HOCK, VICE PRES. & GEN. MGR.
W. BLADEN LOWMYER, SECY & TREAS.

MAIN OFFICE: PIER 2 PRATT ST., BALTIMORE, MD.

BALTIMORE, MD. July 2nd, 1917.

Mr. J. E. Freeman,
Engineer, Technical Division,
Portland Cement Co.
Chicago, Ill.

Dear Sir:-

Replying to your letter of the 28th ulto., file 9-6-1-1 we beg to advise you that we have built three-500 tons Concrete Lighters, through Oscar F. Lackey, the first of which was built about four years ago, and we are using same every day, loading 500 tons of sand or gravel on same and we have had no trouble whatever with her.

They are a little heavier than a wood lighter, tow just as easy.

The second one we built was wrecked in a storm we had some few years ago by breaking away from the wharf at Sparrows Point and being washed ashore on a stone pile was left high and dry, the stone breaking through her bottom.

The third is being worked daily by the Raymond Concrete Pile Company of this city.

In the three or four years that we have used the first large lighter that was built we have never had occasion to use a syphon to pump her out the same as you have to do almost daily with wooden lighters.

These lighters can be seen at Baltimore and we shall be very glad to take anyone aboard whom you might send here.

Yours very truly,

ARUNDEL SAND AND GRAVEL COMPANY.

Vice Pres. & Gen. Mgr.

JJH-E

As an aid to towing, the bilges were rounded on a large radius and worked into sloping ends which were raked back much farther than in the ordinary scow. This scow has been in daily use ever since built and has withstood the roughest kind of handling. Light, the scow draws 4 feet 3 inches, and when loaded to 500 tons has 1 foot freeboard. A letter from

CONCRETE SHIPS

MORTON G. HULL
PRESIDENT

MAXWELL W. UPHON
VICE PRES. AND CHIEF MANAGER

H. H. MOYER
VICE PRES. AND TREAS.

H. B. RAYMOND
ASST. TREAS.

Raymond Concrete Pile Company

SAN FRANCISCO
PITTSBURGH
BALTIMORE
KENNETH K. KIRWAN,
DISTRICT MANAGER

NEW YORK OFFICE
140 CEDAR STREET

CHICAGO OFFICE
111 WEST MONROE ST.

KANSAS CITY
ST. LOUIS
PORTLAND

CABLE ADDRESS "RAYCONPILE"
W. U. CODE

BALTIMORE, MD., July 16th, 1917.
408 MUNSET BUILDING

Mr. J. E. Freeman, Engineer,
Technical Division,
Portland Cement Association,
111 W. Washington St.,
Chicago, Ill.

Dear Sir:

We have your letter of the 13th inst. in reference to reinforced concrete scow which we have in our service.

We are pleased to advise you that this scow has been very satisfactory in every respect and there has not been a dollar's worth of repairs since this scow was placed in commission, about three years ago.

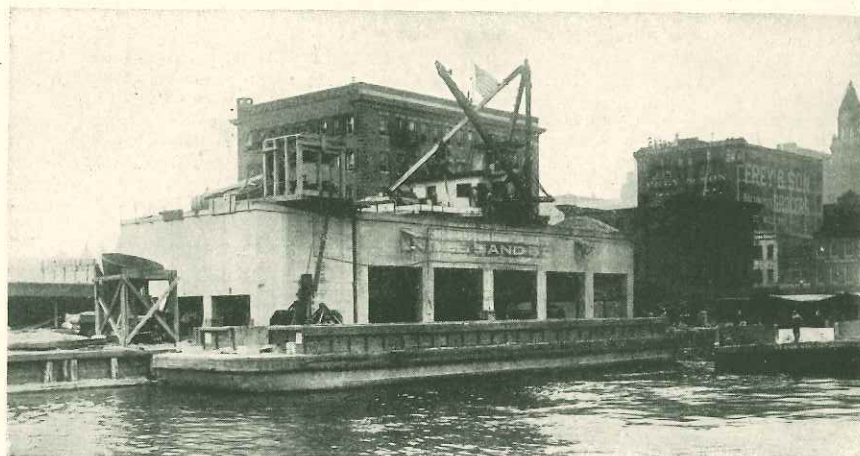
We have taken the liberty of referring your letter to Mr. Oscar F. Lackey former Harbor Engineer of Baltimore, who built and owns this barge. His present address is c/o The Mottisinger Device Mfg. Co., LaFayette, Indiana.

Yours very truly,

RAYMOND CONCRETE PILE COMPANY.

[Signature]
District Manager.

KKK/AM



Concrete lighter of the Arundel Sand and Gravel Co., Baltimore, in service July, 1917, referred to in letter on preceding page.

CONCRETE SHIPS

the Arundel Sand & Gravel Co. reproduced in this booklet tells what the firm thinks of this craft.

Two similar scows were built in 1913 and 1915. One of these broke its moorings in Chesapeake Bay about two years after built and went ashore on a stone pile. The third is used by the Raymond Concrete Pile Co., at Baltimore, a letter from which firm is also reproduced.

CONCRETE MOTOR YACHT

Concrete and Constructional Engineering (London) reports the construction of a reinforced concrete motor cruiser in 1916 by several members of the Sabin Hill Yacht Club, Dorchester, Mass. A view of this cruiser appears on page twenty-nine. The craft is 41 feet over all, with a beam of 8 feet. The following description is taken from the magazine mentioned:

The framing of the boat is of angle steel, and a 10-inch steel H-beam forms the keel. Galvanized expanded steel was attached to the framing to hold the concrete, which tapers from 1½ inches thick at the keel to ¾ inch thick at the gunwale. At each side at the water line, as may be seen in our illustration, is a sponson, which increases the beam to 11 feet, and gives the vessel great buoyancy in a seaway, making her, in fact, practically unsinkable. Power for propulsion is derived from a 25 b. h. p. to 30 b. h. p. four-cylinder Buffalo engine, which gives a speed of 7½ knots. Either petrol or paraffine may be used for running, and the tanks hold 1000 gallons, or enough



Motorboat, "Concrete," built by Walter Dowsey, Iron River, Mich., in 1914, and presented to the United States Naval Reserve, Chicago, October, 1917. The Naval Reserve is now using this concrete boat for practice purposes.

for a cruise of, say, 40 days. Apparatus for developing moving picture films is fitted up in the after cabin, while in the main cabin forward special bunks with deep sides for bad weather are provided.

NAVAL RESERVE BOAT "CONCRETE"

On October 21, there was presented to the Naval Reserve, Chicago, a concrete motorboat that has an interesting history. Walter Dowsey, who for a number of years lived among the lakes in the north woods near Iron River, Mich., tried his hand at concrete boat construction. He built a motorboat by using a T-bar for the keel, the end of which was turned upward to form the prow post. Flat steel 12-gauge by 1-inch was riveted to the keel as ribs on 12-inch centers. Several steel strips on 12-inch centers were then riveted to the ribs lengthwise from prow to stern. Upon this light framework, $\frac{1}{4}$ -inch square wire mesh was attached to cover the entire hull as a ground work to receive the concrete mixture. This in reality was a cement mortar which was applied with a trowel. The boat is 18 feet 6 inches long with a beam of 4 feet 6 inches, thickness of hull $\frac{3}{4}$ inch, depth of hull 38 inches, and the boat has a 6-horsepower gasoline motor.

Considerable publicity was given to the ceremonies that had been arranged to mark the presentation of Mr. Dowsey's boat to the Naval Reserve.

The following is taken from the *Chicago American* of October 19:

U. S. HAS BOAT OF CONCRETE

*Walter Dowsey Brings His Stone Craft Here
for Use of Jackies at Grant Park*

They said Walter Dowsey was crazy, dippy, cracked, wrong in the bean — all the boys about Iron River, Mich. Who ever heard of concrete floating? Nobody. The idea of anyone riding about in a concrete boat! No chance.

But Walter showed 'em. And Sunday all the boys about Iron River can envy Walter. His boat, that eighteen-foot motor boat, made of concrete he made when he was "crazy, and dippy, cracked" and all the rest, is going to be taken over with ceremony for use by the United States government. Walter is an honored man.

It will be used by the Naval Reserve Jackies at the Municipal pier. Dowsey had it shipped by freight to South Chicago, where it was overhauled to conform to the motor boat laws, and today it was put on exhibition at the South Shore Country Club. Tomorrow, it will be exhibited at the Jackson Park Yacht Club. Sunday afternoon it will be formally launched in the government service at the Municipal pier.

"Didn't have any lumber fit for a boat, and no steel," Mr. Dowsey, who has lived most of his life in the North country, explains.

"So I took a steel 'T' bar for a keel, bent up at the ends, made steel ribs, and smeared on the concrete. Worked fine. Been using it ever since 1914."

Recently Proposed Methods of Concrete Ship Construction

CARL WEBER METHOD

Not long ago a system of concrete ship construction was invented and a patent applied for by Carl Weber, 910 South Michigan Avenue, Chicago, a well-known concrete engineer and President of the Cement Gun Construction Co., Chicago. The method patented by Mr. Weber is now being promoted by the Torcrete Shipbuilding Co., of Chicago, which plans to establish plants at various points for the construction of concrete ships of different types.

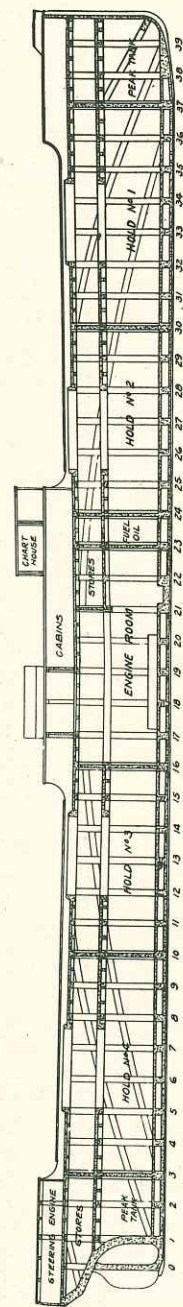
The method proposed by Mr. Weber consists mainly of:

- (1) A skeleton of structural steel with members running transversely and longitudinally throughout the hull;
- (2) A system of reinforcing steel rods supported by the skeleton;
- (3) A layer of wire mesh or fabric placed outside of the steel rods;
- (4) The concrete shell in which the reinforcement is embedded.

Concrete is applied by means of a modified Cement Gun, the modification consisting in dividing the hydration into two stages, and in a special mixing process. Concrete is applied directly to the assembled steel framework, no forms being required other than a sort of shield held on the side opposite from which the concrete mixture is being applied and directly at the point of application. This shield may be slid along as the application of concrete or cement mortar progresses. When concreting has been completed and the concrete has hardened, the exposed surface is rubbed down to a fine smooth finish by means of rotary grinding machines. This method, eliminating as it does, the usual form work, should make for great rapidity of construction.

METHOD PROPOSED BY E. LEE HEIDENREICH

E. Lee Heidenreich, Consulting Engineer, Dwight Building, Kansas City (Mo.), contemplates the construction of a concrete hull with double sides and bottom. The space between the inner and outer shells is divided into compartments by means of short concrete spacers, the object of which is not only to carry the construction from one shell to the other so that the entire hull acts as a monolith, but also to divide the space between the two shells into watertight compartments. The use proposed for these compartments is storage of fuel oil.



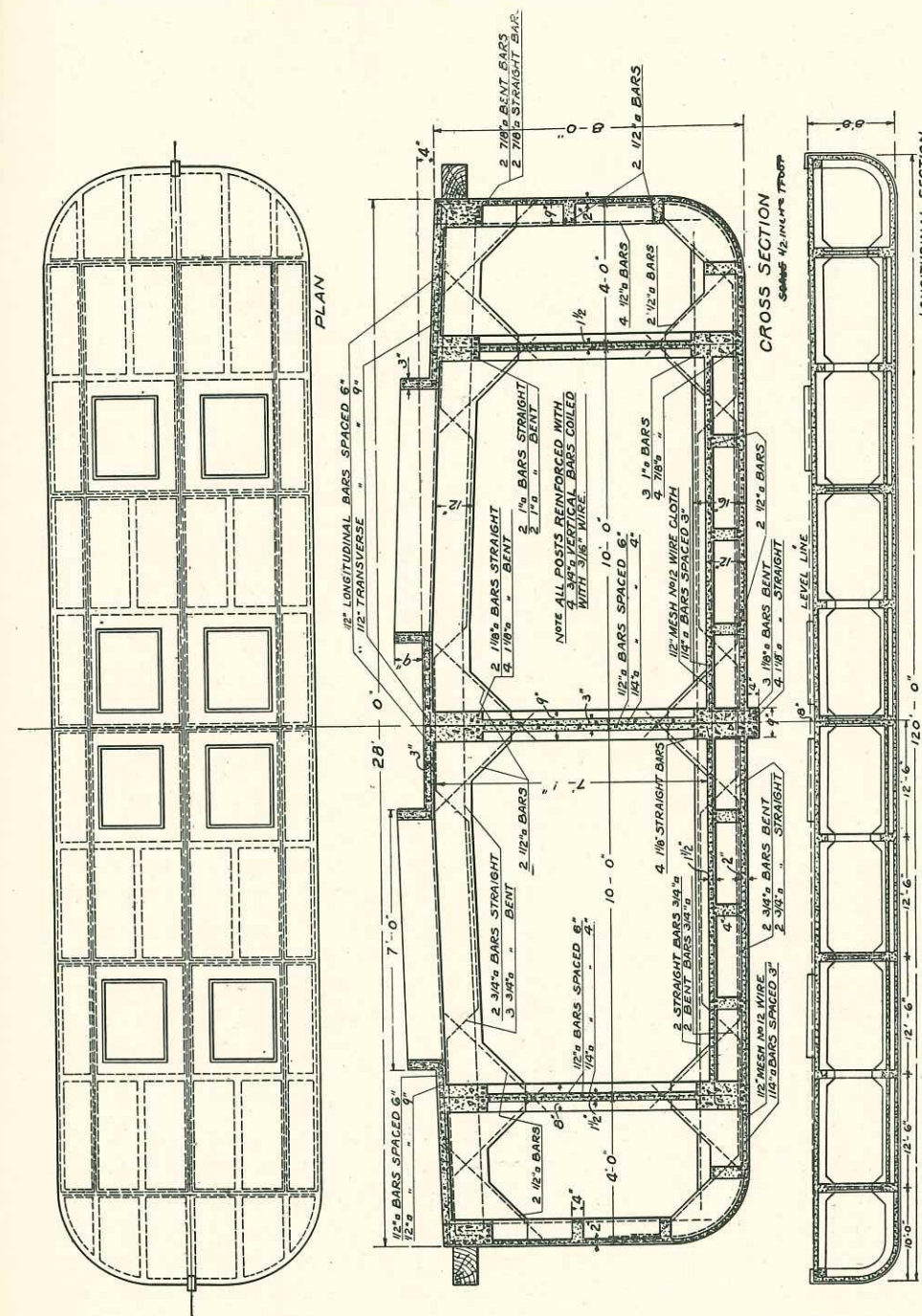
View showing longitudinal section of proposed reinforced concrete freighter 330 feet long. Described in an article by Mr. Hoar, in Marine Engineering, July, 1917.

The concrete in the hull is reinforced by steel rods and wire mesh, forms being necessary so that the concrete can be placed in the usual manner. In the case of large vessels it is proposed to use sliding forms which could travel along the length of the vessel as concreting progresses. These forms will be left in place long enough only for the concrete to harden sufficiently to permit moving forms. This method does away with the large amount of form construction where forms must be built complete for the entire structure, and also permits some standardization of forms so that they may be used repeatedly in building other and similar ships.

METHOD PROPOSED BY JOHN J. SMITH

A method of concrete ship construction devised by John J. Smith, Concrete Engineer, Old South Building, Boston, is somewhat similar to that just described, except that it is intended more particularly for vessels larger than those contemplated by Mr. Heidenreich's method. Briefly, the system proposes a double hull having an outer shell varying in thickness from 5 inches at the water line to 7 inches at the bottom, and an inner shell varying from 4 inches at water line to 5 inches at the bottom. As in Mr. Heidenreich's system, the two shells are separated by concrete spacers, and the space between hulls divided into a number of watertight compartments. These can be used to store fuel oil. The concrete shells or sides are reinforced with steel bars running in both directions. The vessel is built in normal position and the concrete is placed in the usual manner between forms.

In the space between the inner and outer shell, there is a system of interlaced steel rods. The object of this mesh or interlacing of rods is to dissipate the force of any explosion, as for instance that of a torpedo, which might pierce the outer shell. According to Mr. Smith's descrip-



Design for reinforced concrete barge proposed by Allen Hoar, C. E., and described in Marine Engineering, July, 1917.

tion, they are designed to work after the same principle as the Maxim gun silencer. They would not only take up and dissipate the force of explosion, but also protect the inner shell against injury from flying pieces of concrete or metal.

METHOD PROPOSED BY ALLEN HOAR

Allen Hoar, a civil engineer of 3231 Liberty Avenue, Alameda, Cal., now in the Navy Department, proposes a method of concrete ship construction intended primarily for concrete barges and lighters. Mr. Hoar's method also involves a double hull, but the space between the inner and outer shells is somewhat larger than in the two designs just described.

Marine Engineering (New York) for July, 1917, contained an article by Mr. Hoar, in which he showed his familiarity with the subject of concrete ships and barges by pointing out that the use of concrete for floating structures was not a novelty. Mr. Hoar placed great faith in concrete as offering a possible solution of the ship problem because, as he said, it is very essential that another shipbuilding material be available that has as its prime essentials relative cheapness, abundant supply widely distributed throughout the country and particularly near our seacoasts. Mr. Hoar says in part:

The only building material which has these qualifications, together with the necessary physical requirements, is reinforced concrete. This material presents itself as the logical one to replace steel and wood in the construction of ships, not merely as a substitute for steel or wood, but as a material superior to either of these from the standpoint of general adaptability, first cost and cost of maintenance.

Chief among the distinctive advantages of reinforced concrete is its great length of life as compared with either steel or wood. While these materials tend to decay or corrode in a very short time when subjected to the action of sea water and its animal life, concrete, if well proportioned, of first-class materials and properly applied, is absolutely impervious to the action of sea water and proof against boring animal life.

Accompanying Mr. Hoar's article were various details of a proposed design for a reinforced concrete barge and freight steamer. Mr. Hoar contemplates a fleet of concrete barges, each 120 by 28 by 8 feet, capable of carrying 400 tons of cargo. These are proposed for use between various bay and river points around San Francisco. Loaded light, the draft of these barges will be 2 feet 7 inches and the displacement 258 tons. The hull is to be divided into watertight compartments by longitudinal and transverse bulkheads, while timbers will serve as guards to protect the barge from injury by collision.

In connection with Mr. Hoar's article in *Marine Engineering*, the following table of comparisons appeared:

	Reinforced Concrete	Wood	Steel
Estimated life.....	35	15	25
Displacement (light), tons.....	259	135	151
Pounds per cubic foot capacity.....	19.25	10	11.2
Cost per cubic foot.....	.318	.304	.687
First cost.....	\$8,547	\$8,171	\$18,466
Total cost of repairs.....	855	2,432	1,847
Interest on first cost at 5 per cent.....	15,000	6,128	23,082
Interest on repair cost at 5 per cent.....	750	912	1,154
Total cost.....	\$25,152	\$17,643	\$44,549
Total annual cost.....	\$718.63	\$1,176.20	\$1,781.96

Mr Hoar has also designed concrete freight ships having the lines usual to steel vessels, in which his principle of double hull and bottom has been applied. One of his designs is reproduced in this booklet.

METHOD PROPOSED BY BOOKER & McKECHNIE

Booker & McKechnie, concrete engineers of Halifax, N. S., have designed and patented a system of concrete boat construction that also involves a hull having two or more separate shells according to the stresses to be sustained or opposed. The space between the various shells is divided into a large number of watertight cells. Their method proposes for ocean-going vessels three thicknesses of shells under the bottom and two thicknesses from the bottom of the vessel up to water line and one thickness from there upward. The concrete is reinforced by means of suitable rods, the vessel being built in an upright position and the concrete placed between forms in the usual manner.

REINFORCED CONCRETE BARGES AT BAHIA, BRAZIL

Concrete and Constructional Engineering (London) for October, 1917, contains an article by G. C. Workman, which describes the building of some large reinforced concrete barges for the port of Bahia, Brazil. The article is also accompanied by detailed drawings showing the principal features of this work. One barge is described as having been built in April, 1910, to be used for the transport of dredged materials. The dimensions are in metric measures which, reduced to feet, give the following approximations: Length 119 feet, beam 22 feet, depth 9 feet.

Advantages of Concrete Ships

Concrete ships will prove they have many advantages. Some of these will be apparent to anyone, while others will readily appeal to those having shipbuilding experience.

Among the many reasons why concrete fits shipbuilding requirements are the following:

Concrete ships are fireproof.
 Wood-boring worms cannot attack the hull.
 Concrete ships are ratproof.
 Concrete ships require practically no maintenance.
 Construction methods are economical and the cost is low.
 Concrete ships can be built quickly.
 Concrete ships will neither rot nor rust.
 Calking, painting and similar maintenance of the hull is unnecessary.
 Concrete ships will withstand very rough usage.
 Materials required may be obtained readily anywhere at low cost.
 Less labor is required and cheaper labor may be employed.
 There is no likelihood that the hull of a properly designed concrete ship will buckle.
 Because of the smooth surface and the absence of angular projections, skin friction is greatly reduced.
 Concrete vessels may be floated before completion.
 Concrete vessels are lighter than similar ones of wood.
 Barnacles and other sea growths find conditions unfavorable to their growth.

AMERICAN INGENUITY CAN DO IT

In 1909, the United States occupied such an insignificant place in the shipbuilding world that the output of our yards fell below those of Japan. In that year, England led by producing 76 per cent of the world's bottoms. Germany was a poor second; Japan a worse third.

American ingenuity, organization and enterprise is now being directed toward the goal of supplying the world with ships. Suitable lumber and timber are not quickly obtainable. Steel mills are overloaded with work. The shipbuilding material that can be obtained in ample quantities in almost innumerable localities at reasonable prices is concrete. It has been tried and found satisfactory.

All that now remains is for energetic and farsighted marine engineers and shipbuilders and designers in reinforced concrete to work together in applying the knowledge which each has to his particular field to the requirements of shipbuilding. American ingenuity will not balk at the new problems that may arise. That they can be solved is fully demonstrated by the various examples presented in this booklet.

Bibliography

MUCH of the information presented in this booklet has been gleaned from articles that have appeared in various publications, to which acknowledgment is hereby made. Although a summary of the more important of these articles appears in this booklet, those considering the building of concrete ships may be interested in obtaining the

fullest available information on the subject. For this reason the following bibliography of literature upon the use of concrete in boats, barges, etc., has been prepared:

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HISTORICAL SUMMARY OF PRINCIPAL PROGRESS IN CONSTRUCTION OF CONCRETE BOATS, BARGES, SHIPS AND SIMILAR FLOATING STRUCTURES

Year	Country	Description
1849	France	Concrete rowboat built and patented by M. Lambot, of Carces, France. First concrete boat of which there is any record. Also first example of use of reinforced concrete. As late as 1903 this boat was in existence and reported in first-class condition.
1887	Holland	Concrete barges up to 11 tons capacity built. Subsequently barges up to 55 tons capacity built. These were used on inland waters of Holland.
1890	Central America	Concrete rowboat built by P. P. Brannon, Sonsonate, Salvador.
1897	Italy	Concrete pontoon 67 feet long, built for use on inland waters.
1905	Italy	Concrete barges of 150 tons capacity, built by Carlo Gabellini. His system was subsequently used for similar barges in other countries.
1909	Germany	200-ton concrete freighter built for river traffic.
1910	Holland	Concrete motorboat built by R. Last & Sons, intended for use as pleasure craft only.
1910	Canada	Concrete barge built for use on Welland Canal. This has been subjected to very severe usage, is still in use and has proved entirely successful.
1910	United States	525-ton concrete scow built for San Francisco harbor traffic.
1910	United States	Concrete barges built for use at Balboa, Panama Canal.
1910	South America	Concrete barge built for use in the port of Bahia, Brazil. Other barges of same style were built later.
1911	United States	86-ton concrete scow built for sand, gravel, and stone traffic on Chesapeake Bay. First of several scows built after plans of Oscar F. Lackey, then Harbor Engineer, port of Baltimore.
1912	United States	500-ton concrete scow built at Baltimore for Arundel Sand & Gravel Co., after plans of Oscar F. Lackey.
1912	Germany	Concrete sailboat built at Dresden.
1912	England	100-foot concrete pontoon built by Yorkshire-Hennebique Contracting Co., Ltd., Leeds, for Manchester Ship Canal. Still in use and giving very satisfactory service.
1913	United States	Another 500-ton concrete scow built at Fairfield, Md., after plans of Oscar F. Lackey. Built by the Furst Concrete Scow Construction Company.

CONCRETE SHIPS

Year	Country	Description
1914	United States	Two concrete pontoons built for landing stages on Panama Canal.
1914	New South Wales	783-ton concrete pontoon built for Sydney harbor.
1914	United States	Concrete motorboat built by Walter Dowsey, Iron River, Mich. Used by Mr. Dowsey until 1917 when it was brought to Chicago, still in perfect condition, and presented to the Chicago Naval Reserve for use as a practice boat.
1915	United States	500-ton concrete scow built by the Chesapeake Concrete Barge Co., after system of Oscar F. Lackey.
1916	United States	Four more concrete pontoons for landing stages built on Panama Canal.
1917	Denmark	100-ton concrete lighter.
1917	Norway	200-ton concrete lighter built by Porsgrund Cement Casting Works, Porsgrund, Norway. Larger ships now building at same plant.
1917	England	300-ton concrete motorship built for coastwise and channel traffic.
1917	France	Concrete barge built for use on Paris ship canal. Other barges and ships of similar type under construction. Reported that 20 or more of such vessels were in use about the middle of 1917.
1917	Canada	Concrete ship being built by Atlas Construction Co., Ltd., Montreal. Proposed for lake traffic.
1917	United States	Concrete ship approximating 5,000 tons, being built by San Francisco shipbuilding company at Redwood City, Cal. Proposed for transpacific service.
1917	United States	700-ton concrete barge built by Louis L. Brown Co., Inc., New York. Contracts on hand and work progressing on a number of similar vessels.
1917	Norway	Numbers of concrete barges, lighters, and ships varying from 200 tons up to 3,000 tons, being built by Fougner's Steel Concrete Shipbuilding Co., Moss, Norway. Some of these already in ocean traffic between Norway and England.

CONCRETE SHIP DESIGNERS OR BUILDERS

Name	Address
Booker & McKechnie	Davidson Building, Halifax, N. S.
E. W. Brown	Care of Elbert Clark Co., Engineers, Chamber of Commerce Building, Rochester, N. Y.
F. Huntington Clark	149 Broadway, New York.
Nicolai Fougner	Moss, Norway.
Jens Hauland	Porsgrund, Norway.
E. Lee Heidenreich	Temporary address: 958, 55th Street, Brooklyn, N.Y.
Allen Hoar	Dwight Building, Kansas City, Mo.
Herbert Knight	3231 Liberty Avenue, Alameda, Cal.
Oscar F. Lackey	Care of Grant Smith & Locker, 120 Broadway, New York, N. Y.
David Pollock	Care of Louis L. Brown Co., 30 Church Street, New York, N. Y.
Carl Weber	Care of James Pollock, Sons & Co., Ltd., London, England.
J. L. Weller	Care of Torcrete Shipbuilding Co., 910 South Michigan Avenue, Chicago, Ill.
James K. Sherman	St. Catherines, Ontario.
John J. Smith	2608 Campbell Street, Kansas City, Mo.
Louis L. Brown Co.	Old South Building, Boston, Mass.
Atlas Construction Co., Ltd.	30 Church Street, New York, N. Y.
	37 Belmont Street, Montreal, Canada.

THE Portland Cement Association is keeping in touch with developments in the use of concrete for barges, lighters and ships.

We shall be glad to place at the disposal of those interested in this subject information that may be collected subsequent to the issue of this booklet.

■ ■ ■
Portland Cement
Association
111 West Washington Street
CHICAGO

**CONCRETE
FOR
PERMANENCE**

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